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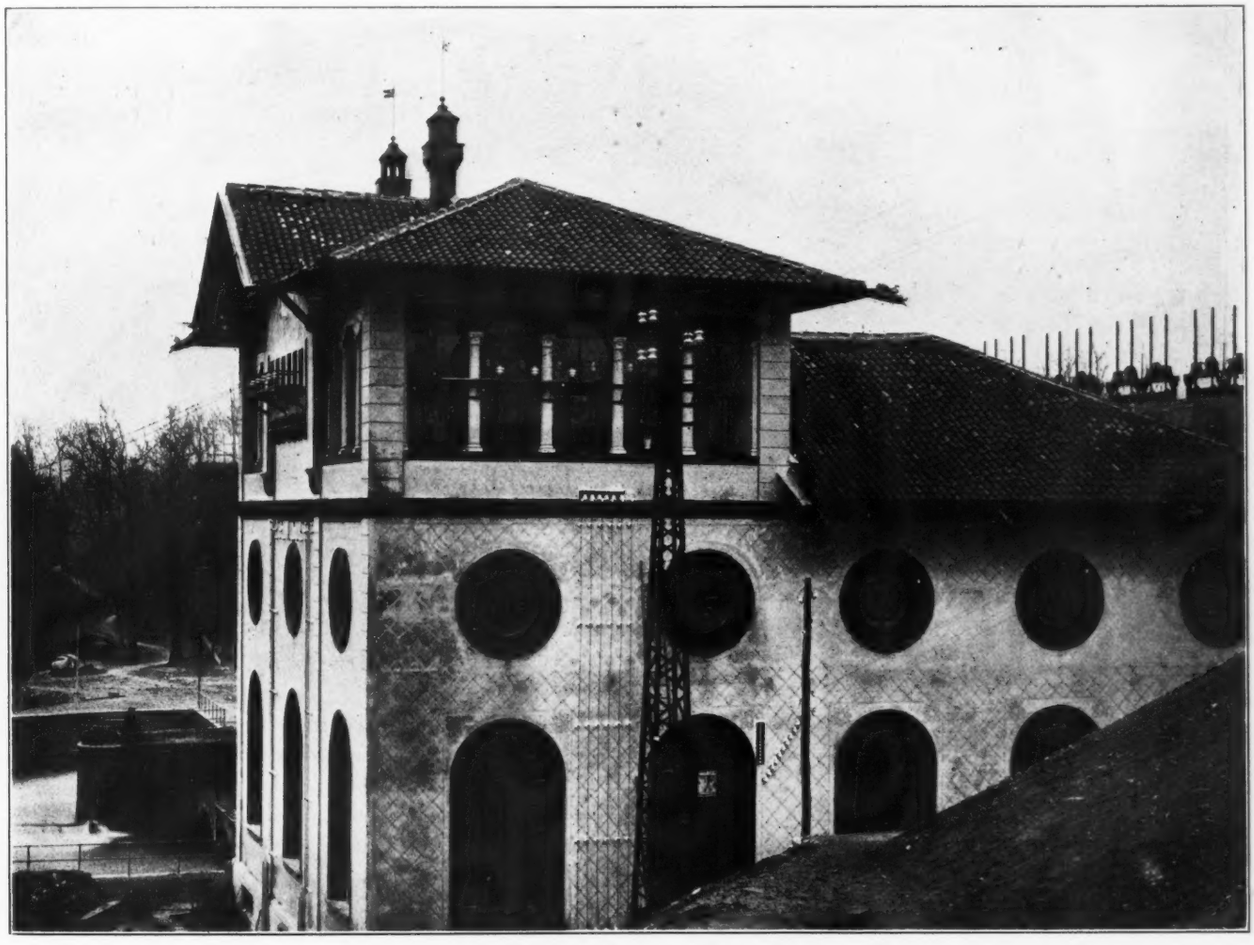
Italian Hydro-Electric Plants on the Ticino River

On the Ticino River, in Northern Italy, several hydro-electric power plants have been installed, some of which differ to a large extent from other similar plants in that it is not intended in every case to supply electric energy to a large number of manufacturing plants located in a single group, or to a large city, but instead the current is transmitted to a large number of independent manufacturing establishments situated at considerable distance from each other, the water power being developed in the heart of an industrial country.

One such group of manufacturing plants is that located on the Ticino River, in Lombardy, Italy, between the towns of Caronno and Varese, these factories being very largely cotton mills, some of which utilize the water power from the river Olona, but this supply being insufficient, and steam plants being expensive to operate on account of the high price of coal, a great hydro-electric power station was installed at Vizzola, where the fall of the Ticino River between Somma, Lombardo and the power plant site is 100 feet, the distance being about six miles.



TICINO-BOFFALORA-VIGEVANO HYDRO-ELECTRIC STATION

This power transmission plant was installed by the Societa Lombarda per Distribuzione di Energia Elettrica. The accompanying illustrations show the location and hydraulic development of the Vizzola plant. The Societa Italiana per Condotte d'Acqua constructed an irrigation canal on the left shore of the river Ticino about two miles from Somma Lombardo. This hydraulic development included a weir 13 feet high and 900 feet long, with a large number of openings or gates having a capacity for admitting 2500 cubic feet of water per second, or the maximum amount due to the canal Villoresi, together with 4200 cubic feet of water per second, representing the quantity of all the down-stream derivations. This development also included a large forebay having a total length of 2000 feet, with pen-stocks at the end and a building erected at the Villoresi canal.

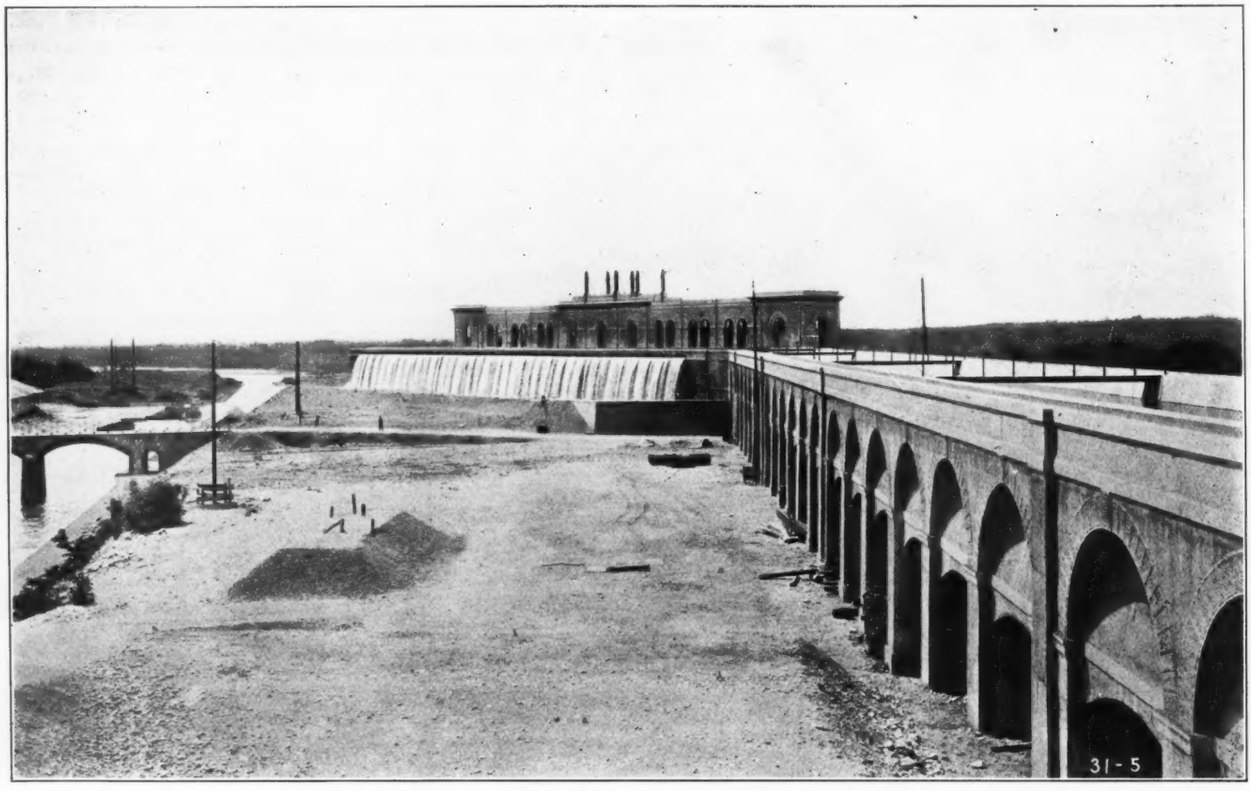
As provided by this development company, 1900 cubic feet of water flows into a navigable canal constructed parallel with and near the canal of Villoresa discharging at Vizzola into the Ticino River and developing power to the extent of nearly 20,000 horsepower.

This new canal is 3.7 miles in length and has an actual normal capacity of 2800 cubic feet of water per second, the fall being 80 feet per mile. It divides into two branches, one passing into the forebay of the Vizzola hydro-electric power plant and the other into the Ticino River through a group of three locks.

The power station is provided with eight turbines constructed at Milan by A. Riva Monneret & Co. and two turbines built at Heidenheim by J. M. Voith. These ten turbines each have a capacity of 20,000 horsepower, operating under a head of 80 feet, and a speed of 187 revolutions per minute. They are directly coupled to 11,000 volt alternators, supplying a three-phase current having a frequency of 50 periods per second at this very high pressure, directly from the stationary armatures of the generator. These alternators were constructed at Nurnberg, Germany, by the Siemens-Schuckert Werke and are supplied with exciting current from three sets of generators. The arrangement of the stations is shown in the accompanying figure.

There are about a dozen three-phase high-tension power transmission lines leading from the Vizzola plant, extending 22 miles to the north to Varese, about 9 miles to the south to Turbigo and about 25 miles to the east to Lomazzo. The power transmission lines are about 95 miles in length, with secondary distribution feeders of about 18 miles. The transforming stations have a capacity of about 16,000 kilowatts, with sub-stations for lowering the pressure for distribution to various industrial plants, about 100 in number, one-quarter of which are centers of secondary distribution circuits to groups of consumers in various localities.

The current is utilized in this manner for operating lights and motors for from 2500 to 3000 consumers in about 70 towns and villages, with secondary and primary conductors 125 miles and more in length. The steam engines in this section of Northern Italy have given way to electric motors; the 20,000 horsepower capacity of the Vizzola plant is taxed to its utmost and a new plant at Turbigo, on the Ticino River, about 9 miles from the Vizzola plant, has been developed, with over 6000 horsepower, further down the river.



VIZZOLA HYDRAULIC DEVELOPMENT AND POWER STATION

It is stated that electric motors are used in the various mills in this district, ranging from 700 horsepower each, three of which are in operation of the induction type, down to the smallest sizes, with an aggregate capacity of over 3000 kilowatts.

On the Ticino River, in Northern Italy, another new hydro-electric power transmission development has recently been carried out which is of the greatest interest to electrical and mechanical engineers throughout the world as exemplifying the latest and most up-to-date methods of power generation, electric current transmission and distribution.

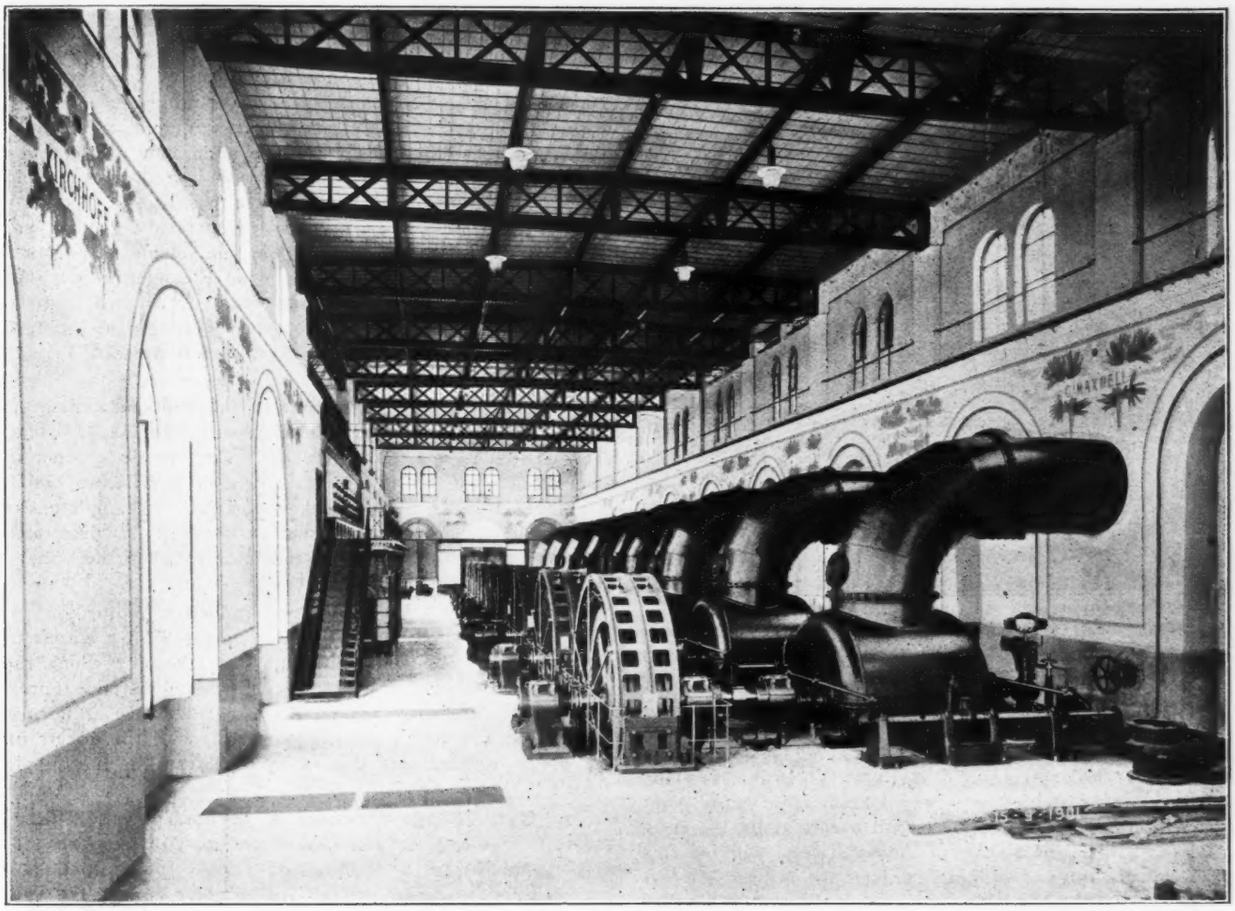
The Ticino-Boffalora-Vigevano hydro-electric generating plant supplies current to a number of large and small cities, such as Milan, Vigevano and Novara, as well as Pavia, all of which have many manufcturing plants, which until recently were operated by steam engines at great expense on account of the high price of coal. During the past decade several hydro-electric plants have been installed at considerable distances from these centers and power is transmitted at high voltages and transformed down for use in factories, mills and workshops, supplementing the steam central stations in those cities, one of which at Milan is provided with the latest types of high power steam turbines.

The Societa d'Imprese Elettrica Conti constructed a modern hydro-electric plant at Brembo and has recently completed the Ticino-Boffalora power station, having a capacity of about 8000 horsepower, with a head of 61 feet, the output being 880 cubic feet of water per second. About one-fifth of the water is taken from a diversion of the Ticino River, the Navigilo Sforzesco, the remaining four-fifths being supplied from an intake on the right bank of the Ticino River at the Boffalora bridge, the normal flow being about 700 cubic feet most of the year and seldom even falling below 350 cubic feet per second.

The powerhouse is about 40 feet in width and 200 feet in length, provided with an electrically-operated overhead traveling crane for the installation of the turbines and generators as well as the transformer plant and to facilitate repairs on the same. There are five turbines of 1400 horsepower each, installed by A. Riva Monneret & Co. of Milan, and two exciter turbines of 150 horsepower each.

These turbines receive the water from an intake 60 feet long, the normal flow of water being 70 cubic feet per second; the water at this speed carrying considerable sand, a sluice gate has been provided having a capacity of 700 cubic feet, through which the sand may be discharged, emptying into the river Ticino below. A concrete channel has been constructed for about one mile from Naviglio Sforzesco to the Boffalora bridge, and for more than seven miles there is a channel which finally divides into two slide gate hydraulic installations, with one channel having a capacity of 350 cubic feet and another of two and a half times this capacity connecting with the collecting basin one mile further down which supplies the water to the turbines in the powerhouse.

There are seven penstocks connecting the turbines with the collecting basin, the head being 60 feet, and a spillway is provided having a width of 80 feet and a total length of about 1300 feet. The water with a fall of over 60 feet drives the two exciter turbines at a speed of 750 revolutions per minute, and the main alternator turbines at 320 revolutions per minute, developing in all about 8000 horsepower for the seven turbines.



VIZZOLA HYDRO-ELECTRIC POWER PLANT.

The electrical equipment was installed at the Ticino-Boffalora power plant by the Unione Elettrotechnica Italiana of Milan, and includes five three-phase alternators, supplying a current of a frequency of 42 cycles per second and 2700 volts pressure, together with two exciter dynamos of 100 kilowatts each, one of which will supply sufficient continuous current for exciting the fields of all of the alternators, the other being held in reserve for use in case of emergency, these units being alternately used for this service.

The high tension alternating current is supplied to the power transmission lines by single-phase step-up transformers, arranged in groups, the pressure being raised from 2700 volts as generated by the alternators to 25,000 volts for transmission purposes. These step-up transformers each have a capacity of 535 kilowatt-amperes, and are of the air-cooled type, a motor-driven blower being provided with each set, and an extra transformer set being available for substituting for a damaged set from lighting or other cause if found necessary.

There are nearly a score of transmission lines connecting the power station with the various towns and cities, iron poles being utilized, the line to Novaro being 18 miles in length and very difficult of construction, probably the worst in Italy, twisting and turning in every direction, while a second line of similar length goes to Milan, and another of the same length to Pavia, about 18 miles from the Ticino-Boffalora station. A shorter transmission lines goes to Vigevano and Mortara, a distance of about 9 miles.

OIL SWITCHES OF THE TICINO-BOFFALORA-VIGEVANO POWER PLANT.

There is a double transmission line to Milan, a distance of 18 miles, the current from these circuits also connecting with Corsico for light and power service. The step-down sub-station at Milan is located at Porta Vigentina, and the line connecting it with the power station is of more than passing interest. A part of the circuit passes along the river Ticino for a distance of over a thousand feet, and for this section of the transmission line pillars are utilized 46 feet in height, carrying the phosphor-bronze cables, each pillar carrying about 35,000 pounds without anchoring. All of these power transmission lines, 18 or 20 in number, are equipped with Perego telephone apparatus, these telephone circuits establishing communication between all of the sub-stations and the power plant. One of the interesting features of this, as well as other Italian hydro-electric plants of recent construction, is the artistic decoration of both interior and exterior, as shown in the accompanying illustrations.

IN BERLIN.

The street lighting of Berlin, at the end of March last, was being done by 32,159 gas burners, 262 petroleum incandescent lamps, 21 alcohol incandescent lamps, 774 electric arc lamps, 180 Nernst lamps, and 14 electric incandescent carbon filament lamps.

THE EFFECT OF VOLTAGE AND FREQUENCY VARIATIONS ON INDUCTION MOTOR PERFORMANCE.

In his first paper on "The Alternating Current Induction Motor," presented at the 14th general meeting of the American Institute of Electrcal Engineers on July 26th, 1897, Mr. C. P. Steinmetz presented a complete analysis on the characteristics and general operation of the polyphase induction motor. In this paper he developed the equations and curves, showing the relation of the speed, output and torque as affected by the applied electromotive force. One of the most significant statements contained in the paper is as follows:

"If in the installation of the motor the mistake is made not to allow for the drop of voltage taking place even in the best transformers on inductive load, but the ratio of transformation is chosen so as to give the rated motor voltage at the secondary terminals of the transformers at open circuit, output and torque of the motor are still further reduced, and even with the best transformers the margin of overload is only 19.4 per cent. in power and 31 per cent. in torque, while with transformers of poor regulation no margin of torque is left, and the motor cannot carry full load any more. That is, at constant primary voltage corresponding to the rated motor voltage at open circuit at the secondary terminals, the motor can be operated successfully only with the best type of transformers. This fundamental importance of transformer and line impedance on the operation of the induction motor has frequently been overlooked. It is, however, analogous to the dropping of torque and output of a continuous current motor, if the impressed voltage drops."

A most valuable supplement to the above statement is printed below from the "Electrical Journal," the paper having been written by Mr. G. B. Werner. Mr. Werner's paper in connection with Mr. Steinmetz's original article, to which reference is made above, makes particularly complete the theoretical and practical information necessary to determine the exact performance of induction motors when the voltage and frequency are variable.

It frequently happens that an induction motor, on account of special local conditions, is operated on a circuit of a voltage or a frequency different from that for which the motor was designed and rated. Under such circumstances, the performance will vary from the performance at normal operation. The following analysis deals with the effects on the motor performance caused by variations in the supply circuit:

1. **Over-Voltage**—Consider a 50 horsepower, 2-phase, 200-volt, 8-pole, 7,200 alternation motor with cage secondary. If this motor is operated on a 220-volt circuit, this 10 per cent-above-normal voltage will slightly change the running characteristics.

The iron loss, which is proportional to a power of the induction nearly equal to 2, is increased 18 per cent., because the induction in the iron (which varies with the voltage) is 10 per cent. greater.

The effect of the change in voltage differs in different motors. In order to give definite figures, however, a particular motor is taken which is to be considered as typical and illustrative of the kind of effects which result from a change in the supply circuit rather than giving precise figures which apply to all motors.

The friction and windage will be roughly the same, as the speed changes only .8 per cent.

The primary copper loss will be smaller, because the current required for the same horsepower is smaller.

The secondary copper loss is only 86 per cent., due to the lower slip, which, for the same horsepower and apparent efficiency, varies inversely as the square of the voltage.

The aggregate losses are a little smaller, resulting in an efficiency .7 per cent higher than under rated voltage.

The magnetizing current, expressed in per cent. of the total current, will for a given motor winding and magnetic circuit, be directly proportional to the square of the voltage (provided the iron is worked below saturation).

The leakage or reactance, expressed in per cent. of the total induction, is inversely proportional to the square of the voltage (since the induction is increased, and the current is decreased).

The power-factor, which may be readily obtained from the relation:

$$\%\ \text{P. F.} = \sqrt{100^2 - (\%\ \text{magnetizing plus}\ \%\ \text{leakage})^2}$$

is 1.2 per cent. lower than under normal operation, due to these changes in the wattless components, directly consequent upon the increased voltage.

The apparent efficiency remains about the same.

The pull-out, or maximum torque, is 20 per cent. greater on account of the reduced leakage.

The starting-torque is also increased 20 per cent.

It is thus seen (Table 1) that operation at 10 per cent. over-voltage in a well-designed motor is quite satisfactory, resulting in higher pull-out and starting torques, higher efficiency, and lower temperature rise; but lower power-factor.

TABLE I.

50 HP—2 Phase—200 Volts—8 Poles—7,200 Alts.

	200 v.	220 v.	250 v.
Output, watts	37,300	37,300	37,300
Slip, per cent.	4.8	4.0	3.1
Pull-out, or maximum torque	3.1	3.7	4.9
Starting-torque	2.1	2.5	3.0
Real Efficiency, per cent.	87.8	88.5	88.8
Power Factor, per cent.	93.2	92.0	86.8
Apparent Efficiency, per cent.	81.8	81.4	77.2
Iron Loss	1,100	1,300	1.650
Friction and Windage	620	620	620
Prim. Copper	1,700	1,410	1,230
Sec. Copper	1,880	1,550	1,180
Total Losses	5,200	4,880	4,680
Real Input	42,500	42,200	42,000
Magnetizing, per cent.	23.6	28.5	41.0
Speed, r. p. m.	856	865	872
Leakage, per cent.	12.9	10.7	8.8
Apparent Input	45,700	45,800	48,300

Note.—Losses are given in watts; pull-out and starting torques are given in terms of full-load torque.

No general rule can be deduced to be applicable to all cases, as the efficiency under abnormal voltage will depend on the relative distribution of the losses; and the power-factor on the relative magnitude of the leakage and magnetizing currents. The power-factor generally decreases as the magnetizing is generally 1.5 to 3 times the leakage.

The foregoing analysis will also apply to the performance at fractional loads. The effect of over-voltage on the power-factor will be more marked; because, at half-load, e. g., the per cent. magnetizing current is nearly double, and the per cent. leakage is about halved. While over-voltage at full-load increased the efficiency slightly, at half-load the efficiency will be reduced; because the iron and friction losses which are practically the same throughout the range of load, are much in excess of the copper losses.

The effect of over-voltage exceeding 10 per cent. will result in a wide variation from the performance at rated voltage (Table I). At 250 volts the magnetizing current is increased to 41 per cent., the iron being worked beyond the bend in saturation curve; resulting in a greatly reduced power-factor. While the starting and over-load capacity (pull-out) are increased, the higher iron loss would jeopardize cool operation.

2. **Under-Voltage**—Taking another representative motor we will note the variation in the performance produced by running at 91 per cent. and 73 per cent. of rated voltage (Table II).

TABLE II.

75 HP—3 Phase—550 Volts—6 Poles—3,000 Alts.

	550 v.	500 v.	400 v.
Output, watts	56,000	56,000	56,000
Speed, r. p. m.	478	473	460
Slip, per cent.	4.3	5.2	8.1
Pull-out	3.6	3.0	1.8
Starting Torque	2.5	2.6	1.2
Real Efficiency, per cent.	89.9	88.6	83.8
Power Factor, per cent.	93.3	94.0	93.3
Apparent Efficiency, per cent.	83.8	83.3	78.3
Iron Loss	1,100	930	600
Friction and Windage	400	400	400
Prim. Copper	2,300	2,810	5,000
Sec. Copper	2,500	3,070	4,930
Total Losses	6,300	7,210	10,930
Real Input	62,300	63,200	66,900
Magnetizing, per cent.	24.9	20.5	12.3
Leakage, per cent.	11.1	13.6	22.7
Apparent Input	66,800	67,200	71,800

When running at 500 volts the efficiency is somewhat lower.

The iron loss is reduced 15 per cent. by the lower density in the iron.

The friction and windage is unchanged.

The primary copper loss is 22 per cent. larger, due to increased current, and the secondary copper loss is about 20 per cent. greater, due to larger slip.

The power-factor is improved .7 per cent. by the smaller magnetizing current, but the pull-out is decreased 17 per cent. by the larger leakage.

The starting torque and apparent efficiency are about the same.

So that, operation at 10 per cent. under-voltage is quite satisfactory, provided the starting and pull-out torques are adequate for the work required; and the design liberal enough, so that the greater losses do not result in an excessive temperature rise.

If the voltage is reduced 27 per cent., that is, if the e. m. f. be 400, factor at fractional loads will be bettered several per cent. by a drop in voltage. At 550 volts the power-factor is 85.5 per cent. at half-load; at 500 volts, 89.2 per cent. The efficiency at half-load, however, is lowered by a drop in voltage.

If the voltage is reduced 27 per cent., that is, if the e. m. f. be 400 instead of 550, the efficiency is greatly reduced (83.8) per cent., and the pull-out and starting torques are about halved, although the power-factor is about the same. Only two-thirds of the horsepower capacity, approximately, or 50 horsepower could be developed, because of the excessive temperature rise, consequent on the large copper losses.

3. **Lower Frequency**—Table III shows the performance of a 50-horsepower, 7,200-alternation motor, when operated on 50 cycles.

TABLE III.

50 HP—2 Phase—200 Volts—7,200 Alts—8 Poles.

	7,200 Alts.	6,000 Alts.
Output, watts	37,300	37,300
Speed, r. p. m.	856	713
Slip, per cent.	4.8	4.8
Pull-out	3.1	3.7
Starting Torque	2.1	2.5

Real Efficiency, per cent.....	87.8	87.6
Power Factor, per cent.....	93.2	92.0
Apparent Efficiency, per cent.....	81.8	80.7
Iron Loss	1,100	1,320
Friction and Windage.....	620	430
Prim. Copper	1,700	1,750
Sec. Copper	1,880	1,880
Total Losses	5,200	5,380
Real Input 42,500		42,680
Magnetizing, per cent.....	23.6	28.5
Leakage, per cent.....	12.9	10.9
Apparent Input 45,700		46,300

On 6,000 alternations, the iron loss is 20 per cent. higher, due to 20 per cent. higher induction in the iron at 83 per cent. of normal frequency.

The friction and windage losses (which vary approximately as the square of the speed) are 30 per cent. less.

The copper losses remain practically unchanged, since the output and voltage are the same.

The resulting efficiency is about the same as that at normal frequency.

The magnetizing current is increased at the higher induction; and the per cent. leakage is lower (the leakage flux being the same for the same current).

The resulting power-factor is slightly lower.

For the same horsepower output at 83 per cent. of rated speed, 120 per cent. of normal torque is required. Since the torque is proportional to the product of the secondary flux and secondary current, at 120 per cent. flux the secondary current should be the same as before. The latter varies with the secondary flux, and the secondary frequency; so that the secondary frequency in revolutions per minute is 83 per cent., i. e., the slip is the same in per cent. as before.

The pull-out and starting torques are both 20 per cent. greater.

A 7,200-alternation motor can thus be successfully operated on 6,000 alternations with about the same efficiency, slightly lower power-factor, increased starting torque and pull-out, and the obvious reduction in speed.

On 3,000 alts., the operation of a 60-cycle motor is impossible at **rated voltage,** on account of the high induction required to produce the necessary torque for the same output and 42 per cent. normal speed. At 2.4 times the normal density in the iron, the iron loss is approximately doubled, and the magnetizing current would be nearly as great as the energy component at the resulting high saturation. The resulting current would make the copper losses prohibitive. In a word, the motor is too small for the torque required.

4. Higher Frequency—On 3,600 alts., a 3,000-alt. motor may be operated successfully with about the same efficiency, improved power-factor; but decreased starting and pull-out torques (Table IV).

The friction and windage is about 45 per cent. higher; the iron loss 13 per cent. lower; and the copper losses about the same.

The decreased magnetizing current (due to the lower induction) raises the power-factor .8 per cent.

The higher leakage lowers the pull-out and starting torque about 17 per cent.

The per cent. slip remains the same; since the full-load torque is 83.3 per cent. of the full-load torque at rated voltage, and the frequency is 120 per cent. of rated frequency.

On 7,200 alts., or 2.4 times normal frequency, cool and efficient operation is obtained, but with very poor starting and pull-out torques.

The iron loss is approximately halved (the density in the iron being 42 per cent.).

The friction and windage are nearly six times as large.

The copper losses are practically unchanged.

TABLE IV.

75 HP—3 Phase—550 Volts—6 Poles—3,000 Alts.

	3,000 Alts.	3,600 Alts.	7,200 Alts.
Output, watts 56,000		56,000	56,000
Speed, r. p. m.....	478	574	1,148
Slip, per cent.	4.3	4.3	4.3
Pull-out	3.6	3.0	1.5
Starting Torque	2.5	1.9	.5
Real Efficiency, per cent.....	89.9	89.9	88.1
Power Factor, per cent.....	93.3	94.1	92.8
Apparent Efficiency, per cent..	83.8	84.6	81.8
Iron Loss	1,100	960	540
Friction and Windage.....	400	580	2,300
Prim. Copper	2,300	2,280	2,400
Sec. Copper	2,500	2,500	2,500
Total Losses	6,300	6,320	7,740
Real Input 62,300		62,300	63,700
Magnetizing, per cent.....	24.9	20.6	10.2
Leakage, per cent.....	11.1	13.2	27.2
Apparent Input 66,800		66,300	68,500

The power-factor is lowered .5 per cent. on account of the high leakage; although the magnetizing is only 10.2 per cent.

The low pull-out might result in frequent stalling on momentary over-loads; and the low starting torque might not be sufficient for a large friction load.

5. Changes both in Frequency and Voltage—From the last two examples of the effect of variations in the alternations of the supply circuit, it is plain that a certain change in the voltage should accompany a change in the frequency. The size of a motor required for a given work is governed by the horsepower per 100 revolutions per minute, so that if a 50-horsepower, 7,200-alt. motor is to be run on 3,000 alts., i. e., at 41.7 per cent. normal speed, the maximum output at which the machine can be rated, allowing the usual over-load margins of reserve, will be about 20 horsepower. To get approximately the same performance, however, the voltage should be reduced in proportion to the frequency, i. e., 83.3 instead of 200 volts. Table V illustrates the case.

It will be seen that although the iron loss and friction losses are low, the copper losses lower the efficiency considerably. The latter are due to the high slip (which for the same torque varies directly as the frequency, and inversely as the square of the voltage).

TABLE V.

50 HP—2 Phase—200 Volts—8 Poles—7,200 Alts.

	200 v. 7,200 Alts.	83 v. 3,000 Alts.
Output, watts 37,300		15,500
Speed, r. p. m.....	856	332
Slip, per cent.....	4.8	11.5
Pull-out	3.1	2.75
Starting Torque	2.10	1.95
Real Efficiency, per cent.....	87.8	77.0
Power Factor, per cent.....	93.2	93.6
Apparent Efficiency, per cent.....	81.8	72.1
Iron Loss	1,100	400
Friction and Windage.....	620	93
Prim. Copper	1,700	2,160
Sec. Copper	1,880	2,010
Total Losses	5,200	4,660
Real Input 42,500		20,160
Magnetizing, per cent.....	23.6	20.9
Leakage, per cent.....	12.9	14.6
Apparent Input 45,700		21,500

With the same induction, the magnetizing current is the same in amperes, but the per cent. is lower on account of the lower apparent efficiency.

The higher leakage reduces the pull-out somewhat.

The power-factor is about the same.

Then again, although the losses can be dissipated, the temperature rise is higher, on account of the less effective ventilation at the lower speed.

As a second instance of operation at different voltage and frequency, consider the 75-horsepower, 3-phase, 550-volt, 6-pole, 3,000-alt. motor on 7,200 alts. Here the speed is nearly 2.5 times as great. If it is desired to keep the **same torque** and raise the horsepower to 180, the voltage should be changed in proportion to the frequency, i. e., to 1,320, to give the same performance. If the **same horsepower** is desired the voltage should be changed as the square root of the frequency, or 852 (Table VI).

For the **same torque,** the induction remains the same, so that the magnetizing current is unchanged in amperes and per cent., since the voltage is raised in the same proportion as the output.

The leakage is also the same, since the induction and current are the same.

The copper losses, in watts, are very nearly the same.

The iron loss is higher at the higher frequency; and the friction losses are nearly six times as great.

The efficiency is improved by the small secondary copper losses; but the starting torque (which is proportional to the slip) is low.

It is seen from this performance that the motor is good for 200 horsepower at 7,000 alts.

TABLE VI.

75 HP—3 Phase—550 Volts—6 Poles—3,000 Alts.

	550 v. 3,000 Alts.	1,320 v. 7,200 Alts.	852 v. 7,200 Alts.
Output, watts	56,000	134,300	56 000
Speed, r. p. m.	478	1,175	1,175
Slip, per cent.	4.3	2.0	2.0
Pull-out	3.6	3.7	3.6
Starting Torque	2.5	1.5	1.5
Real Efficiency, per cent.	89.9	93.0	90.8
Power Factor, per cent.	93.3	93.2	93.3
Apparent Efficiency, per cent	83.8	86.7	84.8
Iron Loss	1,100	3,000	1,300
Friction and Windage	400	2,300	2,300
Prim. Copper	2,300	2,200	940
Sec. Copper	2,500	2,740	1;140
Total Losses	6,300	10,240	5,700
Real Input	62,300	144,500	61,700
Magnetizing, per cent.	24.9	25.7	25.1
Leakage, per cent.	11.1	10.8	11.0
Apparent Input	66,800	155,000	66,200

For the **same horsepower,** the magnetizing and leakage are the same, since both the current and the induction are 35 per cent. lower. The copper losses are lowered, and iron loss is raised. The efficiency is about 1 per cent. higher; the power-factor and pull-out about the same; but the starting torque is lowered by the small slip.

FARMERS' BULLETIN NO. 263, PRACTICAL INFORMATION FOR BEGINNERS IN IRRIGATION.

Issued by the United States Department of Agriculture. Irrigation and Drainage Investigations.

This bulletin gives directions as to the selection of an irrigated farm, the construction of farm ditches, the preparation of land for irrigation, applying water by different methods and to different crops, and the quantities of water to apply at single irrigations and for the season. The bulletin is prepared especially for those who are beginning irrigation, and gives simple, practical directions for their guidance in taking up a kind of agriculture which is new to them.

Application for this bulletin should be made to the Director of the Office of Experiment Stations, Washington, D. C.

INDUCTION MOTORS TO DRIVE NEW YORK FIRE SERVICE PUMPS.

The equipment for the New Gansevoort and Oliver street stations of the Borough of Manhattan, comprising ten multistage centrifugal pumps, each with a capacity of 3000 gallons per minute, will be driven by ten Allis-Chalmers induction motors of 800 horsepower each, which are being supplied in accordance with the specifications of the Department of Water Supply, Gas and Electricity.

These motors will deliver 800 horsepower at a speed of approximately 735 revolutions per minute at full load. They are designed for 25-cycle current supplied at a terminal pressure of 6300 volts. The motors are of the A (N. Y.) type, in which the secondary is provided with a three-phase winding, with the terminal connected to collector rings so that resistance can be inserted at starting in order to limit the current taken from the supply lines. The motors are wound for four poles, thus giving a speed of approximately 750 revolutions per minute at no load.

In order to limit the current at starting and at the same time secure large starting torque, the secondary current is regulated by means of an external resistance inserted in the secondary winding. Leads from the three collector rings will connect to suitable controllers located behind the switchboard, there being one controller with its resistance for each motor. At starting, all the resistance is in series with the rotor winding, and as the motor comes up to speed, the resistance is cut out by means of the controller. A suitable switch is arranged on the motor in connection with the collector rings whereby the latter can be short circuited after the motor has been started, thus avoiding all current in collector rings and brushes during regular operation.

The starting resistance is made of cast iron grids mounted in a substantial cast iron frame and thoroughly insulated.

Each motor, when running at full speed and supplied with current at 6300 volts, will develop not less than 800 horsepower. The efficiency will be not less than 92 per cent at full load.

The stations in which these pumps and motors will be installed are identical in every way, and for the present are laid out to accommodate eight pumping units, the piping being so arranged that it will only be necessary to remove the blank flanges from the tees to make the present arrangement of piping suitable for the operation of ten units.

CONCRETE TELEPHONE POLES.

The Richmond Home Telephone Company's reinforced concrete telephone pole is attracting attention of telegraph and telephone companies in many parts of the United States, says the Indianapolis News. The first pole constructed was set in position recently and the company is preparing to put several others in service.

A dispatch from Richmond that appeared in the Indianapolis News several weeks ago told of the invention of Superintendent Bailey of the Richmond Telephone Company, and this story appears to have gone the round of the metropolitan press, for Superintendent Bailey has been fairly deluged with letters from heads of big telephone and telegraph companies asking for information. As no patent on the pole is possible, Superintendent Bailey is giving his information cheerfully. He said that concrete poles can be manufactured for $6 each. Four twisted steel rods are used to form the skeleton work and the concrete is "poured" about these.

MINING AND ITS RELATION TO THE PAST AND FUTURE DEVELOPMENT OF CALIFORNIA.*

Sixty years ago California was comparatively unknown and only a few Americans had found their way here, coming as trappers and to trade with Spanish settlers who had followed in the wake of the Padres. With the discovery of gold, however, California was brought to the attention of the world and all sorts and conditions of men were attracted here in quest of the precious metal. So it can truthfully be stated that not until gold was found was this state discovered. To mining, then, we must attribute our first start in life and, notwithstanding the fact that many other industries have developed in this resourceful state, mining has kept constantly and prominently to the front.

Mining should be credited with the results of the men who came here originally for gold but who discovered and developed other resources of the state. Of course, there was not gold enough to go around, but in many cases those who diverted their attention to other pursuits were more successful in the end than the actual gold seekers, and certainly the state at large has benefited by the early developing of its resources by the hardy class of men who were drawn to California in the early days in the hope of finding gold, and who could reach here only by undergoing great hardships and privations under conditions that would not be attractive to men of ordinary courage and ability.

We have much to thank mining for in the past and mining is capable of the greatest development in the future. The industry is broadening and becoming more diversified all the time. The last report of the State Mineralogist shows that fifty-four out of the fifty-seven counties of the state produce forty different substances with marked increases in petroleum and structural materials.

In the opinion of many the discovery of petroleum was of greater importance than the discovery of gold. The fuel problem in this state was a serious one until this useful product appeared but the apparently inexhaustible supply of oil provides California with the cheapest fuel known. This is proving very attractive to manufacturers as is shown by our recent progress in that direction.

Copper ranks third in value of minerals in this state, and I am told that this valuable metal is capable of much greater development. The moneyed men of the East seem to take more interest in this particular branch of California mining than do Californians, and they are taking away a lot of money in dividends that might better remain in the state.

Cement and other building materials are of particular interest at the present time. There is going to be a great demand for these products right at home for many years to come, and there is room for great expansion in the several building materials produced in California.

It is not my intention at this time to go into detail, so I shall not attempt to even touch upon many matters that will doubtless be fully covered by others. There is one matter, however, that is of particular interest to California, and which has much to do with the state's development, and that is hydraulic mining. I am not a miner nor am I an engineer, but I am of the firm opinion that a way must be found to carry on this important industry in a manner that will meet with general approval, and a way will be found. The interests of all must be considered in this matter, but as I am informed that there is more gold undiscovered than has been discovered and hydraulic mining is the means to be used, let us get together and devise a plan to carry on this important industry. The navigation of our rivers, the interests of the farmers, and the miners' interests must be taken into account, for they have to do with the state's development.

You will be pleased to know that all of these interests are now in harmony and that the prospects are good for a solution of the problem. As I said before, I am not an engineer, so the physical side must be left to experts, but it does seem possible that the debris might be employed for levees to control the flood waters, and with that idea engineers are experimenting to-day.

The California Miners' Association is to be commended on its efforts to secure a department of Mines and Mining, with the head of the department a member of the President's cabinet. This important industry should have such recognition, and I believe it will.

*Address by Rufus P. Jennings, at the annual meeting of the California Miners' Association, December, 1906.

RULES FOR WIRELESS TELEGRAPHY IN TIME OF WAR.

At the closing session of the Institute of International Law, held recently in Ghent, Belgium, the following articles relative to wireless telegraphy were voted:

The regulations governing wireless telegraphy in time of peace are applicable in principle in time of war. Belligerents may prevent the transmission of Hertzian waves by a neutral state over the high seas within the sphere of their military operations.

All persons taken prisoners while receiving or transmitting wireless messages from belligerent territory or between different sections of a belligerent army are not to be considered spies, but are to be treated as prisoners of war, unless their operations were carried on under false pretenses.

Carriers of dispatches received by wireless who make use of concealment or ruse in their work will be regarded as spies.

Neutral ships and balloons proved to have been used to furnish an adversary with information helpful in the conduct of hostilities may be removed from the zone of hostilities and the wireless apparatus on board seized and sequestrated.

The neutral state is not obliged to prevent the passage across its territory of Hertzian waves destined to a country at war. A neutral state has the right to close or take over the wireless telegraphy station of a belligerent operated in its territory. Every prohibition in the matter of wireless communication made by belligerents must at once be communicated to neutral governments.

ELECTRICITY IN TURKEY.

Electricity is making progress even in the Ottoman Empire, as is evident by the various schemes recently launched. A concession, for instance, for an electric lighting and tramway service in Broussa was recently granted to Mehemed Ali Bey; a Franco-Belgian syndicate has secured a concession for lighting and traction at Philippopol, and a concession for similar dual services in Beirout has been granted to Selim Trad Effendi.—From The London El. Review.

The United States Civil Service Commission announces examinations to secure eligibles from which to make certificatoin to fill vacances in the following positions:

Surveyor in Philippine service, at $1,400 per annum; Topographic and Cartographic Drafstman, at $1,000 per annum; and in the Coast and Geodetic Survey, at $720 per annum.

TELEPHONE ROMANCE AND REALITY; 30TH ANNIVERSARY OF INVENTION.

The world is rushing along through the thirtieth anniversary of one of the most useful and wonderful inventions of that most wonderful century which we have only just left behind us.

It is now only thirty years, which is not even a measured generation, says the Boston "Globe," since Alexander Graham Bell announced to the world, by demonstration at the Centennial Exhibition held in Philadelphia in 1876 that he had discovered a method by which sound, even to the articulation of human language, could be transmitted by wire and conversation held between individuals widely separated.

This achievement had been eagerly sought by various scientific students through several centuries; and more than two hundred years before Robert Hock had succeeded in perfecting a device by which sounds were conveyed to a distance, a device which was followed at intervals during the nineteenth century by various inventions by Wheatstone, Page, Bourseul and Reiss. These inventions were efforts in the right direction, and that of Page, of Salem, closely approached the telephone as finally perfected.

A Scientific Toy.

Of the great masses who visited the Philadelphia Exposition of 1876, comparatively few remember to have seen the telephone exhibit of Professor Bell; many who saw it failed to be impressed further than to regard it as a scientific toy, and no one was impressed with its worth as a useful discovery destined to bound into public favor and become indispensable in social and commercial matters.

But never before in the world's history did a discovery of such moment make more rapid strides of progression over a pathway strewn with such obstacles at every step.

The straitened circumstances of the inventor and the incredulity of the public would have defeated a less learned and persistent discoverer. The efforts and the sacrifices of Professor Bell are oft repeated and familiar stories, and the individuals who rejected offers that would have made them millionaires are as numerous as those who miraculously escaped death by missing the train that went to wreck and ruin.

But fewer are familiar with the fact that the invention which it had taken centuries to evolve and which had been presented to the world at one of its great international expositions, was two long years in meeting with any serious consideration, and then only by the most indefatigable efforts of two adventurous promoters who introduced it to a few straggling customers in a Connecticut city. It may also be cited as a peculiar feature of the telephone discovery that the grandfather of its inventor had devoted his life to teaching the deaf and dumb to converse with their more fortunate fellows; that his father had invented a system by which it had been more easily done and that he, a Scotch emigrant to America, was engaged in still further bridging the chasm when he found the means of communication between individuals who were seemingly even more separated by distances than if the human family were all deaf and dumb.

Strange Coincidence.

An interesting little episode of the genesis of the telephone is drawn from two entries upon a single page of the blotter of the chief clerk of the patent office at Washington, out of which there grew a multitude of legal combats which engaged the courts, from the lowest to the highest, and cost the contestants hundreds of thousands if not millions of dollars to prosecute and to defend.

It was February 14, 1876, Valentine day of the Centennial year, when Professor Elisha Gray, of Chicago, quietly entered the patent office and presented the usual formal papers, designated as a "caveat." He paid the usual fee and departed. On the same day Alexander Graham Bell entered the same office and filed with the same clerk the usual formal papers, designated as an "application for a patent," and he also paid the usual fee and departed.

The caveat set forth that Elisha Gray had discovered a method by which the human voice in conversation could be transmitted to a distance by means of a wire, and he thus sought protection while perfecting it.

The document filed by Alexander Graham Bell made the claim that he also had discovered a method by which persons separated by distance could hold conversation by the use of the contrivance for which he was seeking to be protected by patent.

It does not appear that either knew of the other's presence in the patent office on that February day; but they both went their way, and were not long in making the discovery that the fate of their respective claims hinged upon the time of day when each had filed his papers. If the caveat was presented a second in advance, then Professor Elisha Gray would bear the honor and reap the financial reward of having given to the world one of the greatest inventions it had yet seen.

If, on the other hand, the application for a patent came first, then Alexander Graham Bell bore the distinction and reaped the reward.

To settle this one question courts were besieged, volumes of evidence taken, and fortunes expended with the result, as the world knows, that Professor Bell established his claim.

The First "Central."

Notwithstanding the world was incredulous as to the merits of the toy telephone for practical use, the evidence that the world was seeking just the thing it eventually proved to be is forcibly illustrated by the action of the business men of Bridgeport at about the time the little scene recited above was being enacted. A social telegraph company was organized at Bridgeport, and while the exact date of its organization is not known it is a fact that it was in full operation early in 1877.

Houses and business offices were connected by wires which were run to a central station and there connected upon a switch board. This was the first "central." When one member of the company wished to communicate with another member he would begin calling, and the call would be sounded at the central station, where the operator, ascertaining the wishes of the caller, immediately connected the wire with that of the person sought, and then business men, clerks, bookkeepers and even the women in the homes became telegraph operators, and it was said that there were more operators in Bridgeport than in any community of its size in the world. It has been suggested by one writer that had the telephone not come along we might have become a nation of telegraphers.

Mr. Doolittle, who was one of the members of the Social Telegraph Company, of Bridgeport, and an ingenious man beside, conceived the idea of attaching the new and untried telephone to the telegraph wires, and, it proving to be a success, he bought the plant and converted it into a telephone company. To this day it is asserted by Bridgeport people that they have the honor of having enjoyed the luxury of the first telephone exchange. However that may be, the claim is contested, as will be seen by the following very interesting account of the struggles of New Haven contestants for first honors.

The First Telephone Exchange.

It was in the latter part of the year 1877; more than a year had passed since the telephone had been exhibited at the World's Fair in Philadelphia; almost two years had gone by since Professors Bell and Gray had announced their dis-

covery. Yet the world had given no further evidence of appreciation of the marvellous discovery than was found in the adoption of a stray instrument here and there by some one more curious than his fellows, who wished to connect his house with his business, or perhaps, adopt a means of enjoying an occasional chat with a neighbor.

The inventor himself had not yet evolved a scheme by which his priceless discovery might be generally utilized for commercial and social purposes, when George W. Coy and H. P. Frost, of New Haven, got the agency for its introduction into New Haven and Middlesex Counties, Conn. They began by organizing a company, which was represented by $5,000 in stock. The promoters each appropriated $2,000 of the stock and transferred the remaining $1,000 to Mr. Hayward, special agent for the Bell Company, for the use of the instruments.

To give some idea of the hopes of even the promoters of the first local company, it may be stated that they were well nigh discouraged in the very beginning of their enterprise by the stipulation of Special Agent Hayward that 100 instruments would be the minimum number which would be rented to them. It is a matter of doubt if they would have proceeded with their undertaking had Mr. Hayward not relented and reduced the limit to seventy-five.

Coy was without means, as was Frost also; but Mr. Frost borrowed of his brother-in-law $650. One thousand circulars were mailed to representative men of New Haven, in which the scheme was outlined and a blank application embodied; and then Coy and Frost sat back and awaited the rush of return applications. But it is recorded that the only answer to their thousand circulars was from one of the resident ministers who wished to be progressive and signed outright for a telephone.

Their next move was to secure a canvasser, to whom they offered a commission of $1 for each subscriber obtained, and by the end of sixty days their books showed one hundred and fifty subscribers. By this time Coy had studied the telegraphic switchboard and had devised a system of connection and exchange of wires in a central office out from which the wires were speedily run over the housetops to the various customers who were to enjoy the luxury at the yearly expense of $22.

Everything connected with this pioneer exchange was crude. Mr. Coy, with the assistance of one boy, ran the exchange. Call bells had been invented, but their cost, $18, was too steep, so Coy adopted a push button that resulted in a squeak that could be heard over a room and which came to be termed "Coy's chicken." The receiver and transmitter were both one, which caused the officer to post over each instrument this reminder: "Do not talk with your ear or listen with your mouth."

Starting the "Hello."

The "hello" system thus established in New Haven, its fame spread abroad through the land and its projectors began to be overwhelmed with inquiries from every nook and corner of the globe. But they had no time to open a school of education by correspondence, for they must broaden their own field of operations. Four hundred and fifty telephones had been introduced with their initial effort, and they next tackled Hartford, in the Fall of 1878, where they repeated their New Haven success, and then went on to Springfield, in the Spring of 1879, where the first man approached was the famous journalist, Sam Bowles.

"What do I want with a telephone," said Bowles, "to talk with myself?"

When assured that he could subscribe conditional upon the introduction of one hundred instruments at Springfield, he subscribed, and with the name of Bowles heading the list the rest was easy.

In branching out from New Haven these two conquerors had organized the Connecticut District Telephone Company, with a capitalization of $40,000. They retained $10,000 worth of the stock for themselves, gave $12,000 worth of it to the Automatic Fire Alarm Company for the use of its wires at Hartford, and sold the balance. At this point the Western Union Telegraph Company saw trouble ahead for their business if the growth of the telephone continued, and sought to get control.

At a preliminary meeting the Western Union held enough stock with the proxy of the Automatic Fire Alarm Company to control the meeting, and avowed its intention to oust Coy and Frost at the very next meeting. The stock owned by the Automatic Company was held in New York, and thither went Coy and Frost to make a play for its control, which, with their own holdings, would give them $22,000 and a majority of the $40,000 stock.

When the Bell Company Didn't Have $3,000.

The Western Union had bid $6,000 for the Automatic stock, and Coy and Frost upon their arrival in New York gave the Automatic people $500 for an option of twenty-four hours to buy their holdings at $6,500, which sum they had hopes of raising. The $500 paid for the option was in the form of a check on a New Haven bank, which was more than likely to be "returned for want of funds." However, they made the bluff, and the bank upon which it was drawn stood by the "hello" pathfinders and honored it.

Their anticipated source of raising the $6,500 failed them; their option limit, which was three p. m., was drawing near. They got it extended to four o'clock and applied to the Bell people to raise half the amount, but a quiet reckoning among that crowd of future millionaires failed to disclose the coveted amount. The Bell Telephone Company, individually or collectively, could not raise $3,000, and so in desperation Coy and Frost sought the wizard of finance, Jay Gould, who at that time was intent upon the labors of a new telegraph company organized to buck the Western Union.

Gould heard their story, and saw his opportunity, and they left him in haste with the requisite amount to close the option on the stock that was to place them in control of the company they had worked so hard to organize. Again they had won out, and when the battle and the business of the day was over and they had outclassed a powerful corporation that had sought their commercial downfall they were reminded that they had not eaten, and away they went to dinner. After satisfying the inner man they needed to get back to New Haven.

"By the way, Coy," said Frost," "you'll have to pay our fare to the station." "Haven't a sou," said Coy, and the two indomitables, who had so recently been closeted with the Tsar of Wall street on a scheme involving thousands, now had no alternative but to "hot foot" it for the railroad station over which they had return tickets to New Haven.

When the early "centrals" were established the operator called every subscriber by name, and the mental limit was about six hundred.

The change from names to numbers came about in a very curious way. There was an epidemic of measles in Lowell, and Dr. Moses Greeley Parker, one of the original directors of the Bell Company, expressed his opinion at a meeting of the officials that if the Lowell operators, or a majority of them, were to fall victims of the epidemic, the business of the telephone exchange there would be at a standstill, as substitutes would be unable to master the names of all the subscribers at short notice.

Approximately, the switchboards of the Bell Telephone Company have cost $20,000,000. The largest of these boards at present in use contains 4,000 miles of wire and 15,000 tiny electric signal lamps.

Now It Girdles the Earth.

Volumes would be necessary to recite the interesting features and experiences of the pioneers who were instrumental in demonstrating the usefulness of an invention that has proven itself to be one of the chief blessings to be evolved from the brain of man. And never, perhaps, in the world's history, have there been such marvellous developments from any one mechanical discovery as have followed the introduction of the Bell telephone.

From a mere toy on exhibition among the varied curios displayed at the Centennial it found an indispensable place in commerce, at first connecting business houses in the smaller communities, thence into the great centres and finally connecting the great marts one with another, by means of which fortunes have been made and disasters averted during unexpected fluctuations of an erratic market. Its aid in social affairs has come to be recognized as indispensable.

When it is remembered that more than fifty million of the American people, to say nothing of the world's millions, even of darkest Asia and Africa, are familiar with the hello blessings which are the discovery and growth of thirty years, who will hazard a prediction of the telephone growth in the thirty years to come?

REGULATIONS FOR DENATURED ALCOHOL.

The regulations prescribed by the Commissioner of Internal Revenue for the manufacture and sale of denatured alcohol, under the Act of Congress which is to take effect on January 1, 1907, provide for strict government supervision and the establishment of separate bonded warehouses, which may be used only for denaturing purposes. The bond required must be for a penal sum of not less than double the tax on the alcohol it is estimated the distiller will denature during a period of thirty days.

Not less than three hundred wine gallons of alcohol may be withdrawn from the distillery warehouse at any one time for denaturing purposes. This alcohol must be denatured before the close of business on the day following that upon which it was withdrawn.

Unless otherwise specially provided, the agents used for denaturing alcohol must consist of methyl alcohol and benzine in the following proportions: To every one hundred parts by volume of ethyl alcohol of the desired proof (not less than 180 degrees) there shall be added ten parts by volume of approved methyl alcohol and one-half of one part by volume of approved benzine; for example, to every one hundred gallons of ethyl alcohol (of not less than 180 degrees proof) there shall be added ten gallons of approved methyl alcohol and one-half gallon of approved benzine. Alcohol thus denatured will be classed as completely denatured alcohol.

Methyl alcohol and benzine intended for use as denaturants, must be submitted for chemical test and must conform to the specifications prescribed.

The above mixture may not be adapted for use in certain industries, and to provide for this the Commissioner of Internal Revenue will consider any formula for special denaturation that may be submitted by any manufacturer in any art or industry and will determine whether the manufacture in which it is proposed to use the alcohol belongs to a class in which tax-free alcohol withdrawn under the provisions of this act can be used, and whether or not it is practicable to permit the use of the proposed denaturant and at the same time properly safeguard the revenue. But one special denaturant will be authorized for the same class of industries, unless it can be shown that there is good reason for additional special denaturants.

The Commissioner will announce from time to time the formulas of denaturants that will be permitted in the several classes of industries in which tax-free alcohol can be used.

The regulations provide that neither completely nor specially denatured alcohol may be kept or stored on the premises of dealers in wines, fermented liquors or distilled spirits, rectifiers of spirits, manufacturers of and dealers in beverages of any kind, manufacturers of liquid medicinal preparations, manufacturers of vinegar by the vaporizing process and the use of a still and mash, wort, or wash, and other persons who, in the course of business, have distilled spirits, wines, malt liquors, or other beverages stored on their premises. By special provision, druggists are exempt from this restriction.

Dealers in the denatured product are required to have a permit from the collector of internal revenue, and must keep a correct record of all transactions involving its purchase or sale.

While these regulations are very strict, it is believed that they will permit a very free use of industrial alcohol, and will be found generally satisfactory to those interested.

COMMON WASTES.

In a paper recently read before the Association of Engineers-in-Charge in England, Mr. James Swinburne commented on the negligence of consumers who use electricity or gas for lighting purposes.

If we study, he said, a system of, say gas production and distribution, we find at one end a most elaborate plant for manufacture, in which each part is carefully suited to the end in view, and is calculated to give the results desired with the greatest possible efficiency and economy. The coal is all bought in the best market, and brought in the most economical way to the retorts. The retorts are designed to give the maximum yield of good gas with a minimum cost of labor and wear and tear, and the smallest consumption of fuel. The coke is sold, and the tar and other byproducts are worked up into a form which will bring in the biggest profit. The gas is sent along pipes and through meters made as accurate as is consistent with economy, and is then the property of the consumer. Up to this point the greatest care has been devoted to economy and efficiency in every detail. But what do consumers do with their gas? They just set light to it and let it burn away, and are quite content if they get a little light, until the account comes in. Then they sometimes grumble.

It is just the same with electric light. A modern central station is a marvelous study of economical production. There is no industry in which costs are so carefully examined or so accurately worked out. But all questions of economy end at the consumer's meter. He uses blackened lamps, which are marked incorrectly to begin with, and he covers every light with useless and dirty shades, and has his lamps in the wrong places.

It is not that the supply companies take no interest in the matter after their product has passed the meter; quite the reverse, they are most solicitous for the welfare of their customers. The gas people, for instance, do their level best to persuade their consumers to use the best burners or to employ mantles and get the best results. They try hard to persuade the consumer that a penny burner that gives one candle per cubic foot is not so economical as a slightly more expensive kind that gives more than two. It is true that the better burners will use less gas for a given light, and will therefore tend to reduce the gas bill, and the company wants to increase the gas bills; but the company really wants the consumer to use the gas well and economically, because if he does so the total supply of gas will increase in the long run. It is just the same with electric light; it pays the companies if the consumers use good and economical lamps They will finally want more light rather than smaller payments, and the total supply will go up.

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EDITORIAL.

The Importance of the Load Factor

The term commonly called load factor is the ratio of the average demand during a given period to the maximum demand or peak load during the same period. The load factor is usually expressed in per cent, and while it is more often applied to electric light and power system, yet it equally well may be used in the same general sense in connection with the manufacture and distribution of gas and naturally also to electric railway systems. As usually interpreted, the load factor is applied to a one-day or a twenty-four-hour period, and, therefore, gives the ratio of the average demand during each twenty-four hours to the maximum demand at any time during the same period.

There can be no reason why the term load factor should not also be applied to periods of time greater than a single day. In fact, where illumination is involved, a study of the annual load factor, or the maximum demand during the season of short days as compared with the average load for the year, is of great commercial importance. The necessity of providing for the peak load during the winter season can be no better expressed than in the words of a manager of an extensive electric light and power installation, who recently said that a large part of his time during the summer was spent in perfecting plans and ordering new apparatus to be delivered and installed in time for the peak load of the winter season.

Commercial lighting, particularly for residence and store illumination, always tends to lower the load factor for the twenty-four-hour period. It is perhaps for this reason that there has been a gradual but very definite tendency for electric lighting plants to rearrange their business so as to combine electric power service during the day with electric illumination at night. When applied to transportation systems, the congestion of the traffic during certain hours of the day causes the load factor to be low or the maximum demand for power to be excessive during such periods of congested traffic. Ordinarily the operation of individual motor cars results in a higher load factor than the combination of a number of motor cars in a train. The trans-bay traffic to and from San Francisco is a striking illustration of the congestion of traffic, particularly during the late afternoon hours. To accommodate the passengers on a single ferry boat a number of trans are required, and all of these trains, fully loaded, are necessarily started and are in operation at the same time.

Low load factor in electric power plants makes necessary duplicate units and a large generating station for a given total output in kilowatt hours, while for gas and electric distribution large mains and an increased number of sub-stations are often required. While large gas holders provide ample storage, the drop in pressure in the gas mains at the time of peak load must be given due consideration and regulators or governors are required properly located in the distribution system. In electric power plants the only apparatus which corresponds to the gas holder in the manufacture of gas is the storage battery, which can only be used with direct current distribution. While the installation of a storage battery increases the efficiency of the generating station by increasing the load factor, storage battery installations are quite expensive and at best involve an increase in the cost per kilowatt hour, as compared with a similar station having a good load factor, due to the uniform demand for power at all times during the day.

A storage reservoir at the head of the pipe line makes it possible to carry a large peak load on a water power electric plant. For this reason, and also because such storage reservoirs can supply for a short time sufficient water to carry the normal load in case of a break in the water conduit system, they are, whenever possible, included in the hydraulic development.

The cost of manufacturing and delivering a given amount of electrical energy or gas, as above indicated, depends largely upon the effect on the load factor of the power delivered. In addition to the magnitude of the demand, the time during which the electric power or gas may be required during the day, must also be taken into consideration. The cost to the consumer, therefore, per kilowatt hour or per thousand feet may vary within extraordinarily wide limits and it is due to the fixed charges required to properly equip a plant for its peak load that the cost per unit of energy during this period is many times seemingly excessive.

BOOK REVIEWS.

The Register of Cornell University for 1905-1906 is a 645-page, paper bound book, containing specific information of academic interest.

The mid-November number of the Proceedings of the American Society of Mechanical Engineers is devoted exclusively to an address "On the Art of Cutting Metals," which was delivered on December 4th by the President of the Society, Mr. F. W. Taylor. This address embodies the results of exhaustive and painstaking experiments conducted in various machine shops for a period of twenty-six years, and will undoubtedly have a most decided influence on machine-shop practice of the future.

Mr. Taylor set for himself the very important problem of how to enable the machinist to select the most satisfactory tool, cutting speed and feed for any given piece of work. In this paper he has confined himself to that kind of machine shop work known as "roughing," that is, preparing forgings or castings for the final finishing cut, which is only taken when great accuracy or a high finish is desired.

The results cover 248 pages of verbal matter, 4 folder plates of half-tones, and 24 folders of drawings, curves, tables, etc., and are entirely too numerous and too detailed to permit even a scanty review in these columns. Too much can hardly be said about the practical value of these results; and no doubt many will look forward to the details of the discussion which this paper called forth at the meeting of the Society.

TRADE CATALOGUES.

Those who are unfamiliar with the extent to which electricity and electrical appliances may increase the comfort and luxury of the home, will find enlightenment in the attractive Christmas bulletin of the Portland General Electric Company. In addition to some interesting matter on the lighting of stores, there are timely suggestions for increasing the brilliancy of Christmas decorations.

Recent publications of the General Electric Company:

Bulletin No. 4466. Field rheostats for the remote control of railway generators and rotary converters are described in detail.

Bulletin No. 4470. Several excellent photographs show G. E. electric motors driving machinery at the sawmills of the Stearns Lumber Company, Stearns, Kentucky. The hardy and simple character of induction motors makes them especially fitted for this class of work.

Bulletin No. 4473. This bulletin is descriptive of the G. E.-81 direct current railway motor which embodies the latest improvements in General Electric railway motor design. This motor is rated at 30 horsepower, and is designed for a pressure of 500 volts.

Electric Mine Locomotives. This is a 53-page catalogue dealing with underground haulage. The photographs are of unusual interest, and serve to leave a vivid impression of the operation of these locomotives at various mines throughout the country.

Allis-Chalmers Company's Bulletin 1506 describes electrically-driven hoists for mining work. The standard hoists with single or double drums are built for capacities ranging from 1800 to 6200 pounds.

The Spokane & Inland Empire Railroad has just published an unusually attractive booklet descriptive of Spokane and the territory traversed by the company's lines. There are many photographs to show the character of public improvements in Spokane and present industrial conditions, as well as interesting bits of scenery in the states of Washington and Idaho.

PERSONAL.

Mr. Wm. H. Browne has resigned his position as director, treasurer and general manager of the Stanley Investment Company of Great Barrington, Mass., which was obliged to discontinue business by an injunction obtained by the Westinghouse Company in a patent litigation. Mr. Browne has as yet made no definite plans for the future. His present headquarters are at No. 34 Pine street, New York City.

Mr. Frank G. Baum, who has been in charge of the hydraulic and electrical engineering and construction and also the operation of the system of the California Gas & Electric Corporation for the past three and one-half years, has resigned his position, to take effect January 1st, 1907, in order to go into consulting engineering, his specialty being hydro-electric power plants and long distance transmission systems.

Mr. Baum will continue as consulting engineer for the California Gas & Electric Corporation, and will have his offices on the fourteenth floor of the Chronicle Building, San Francisco, Cal., about January 15th.

Mr. Baum is a member of the A. I. E. E. and the A. S. M. E., Asso. A. S. C. E. and a vice-president of the A. I. E. E.

POWER FROM THREE-PHASE CIRCUITS.

In a paper on "The Measurement of Three-Phase Electrical Power and Energy," read in September last before the South African Association of Engineers, Prof. J. H. Dobson entered upon a theoretical examination of the subject, and suggested remedies for the removal of errors in the measurements. He was of the opinion that wherever possibility of error may arise, a system of measurements should be adopted which records the consumption of energy accurately beyond all doubt within the ordinary allowable limits of error, and under the conditions specified; and believes that single-phase reading wattmeters placed on station switchboards for the measurement of three-phase power should be arranged to read right and left of a central zero, and that two-instrument methods of measuring the consumption of three-phase energy should be abandoned. He then pointed out that in balanced circuits one instruments is sufficient to measure the power and energy, but in an unbalanced circuit two pressure and two current coils or their equivalent were necessary to measure the power and energy correctly. In the case of energy measurement these latter, however, need not necessarily be two distinct instruments mounted on one base, as arranged by some manufacturers. At least the two parts may be caused to produce a resultant torque on one spindle, which consequently has only one set of reading dials or numbers. When correctly connected up the sign of the torque could never reverse, as the author explained, and the resultant torque would be T_{w1} plus T_{w2} and the monthly difference of readings would always give the true consumption of energy similar to that of ordinary single-phase instruments. There are already a few instruments on the market made on the above principle, and, having one set of dials, they are not only cheaper but more reliable.

The United States Civil Service Commission announces examinations to fill the following vacancies: Computer in the Coast and Geodetic Survey, at $1000 per annum; civil engineer, Philippine service, at $1400 per annum.

A recent dispatch from Berlin stated that Vice Admiral von Eickstedt, director of the Construction Bureau of the Navy Department, announced at a meeting of the Technical Shipbuilding Society that the German Navy intended to use turbine engines in the future. Emperor William was present during discussion on the subject.

THE GREATEST LOSS.

The following article from the editorial columns of The Mining and Scientific Press so completely covers the ground, which is very well entitled "The Greatest Loss," that we take pleasure in reproducing it for the benefit of the readers of "The Journal." The aggregate industrial losses incident to the recent catastrophe are becoming the more appreciated as time goes on. It is the loss that cannot be duplicated either with money or anything else that is the most serious:

"We have dwelt upon many features of the earthquake-fire that turned the sympathies of the world toward San Francisco in April. There remains one lesson, and the chiefest of all, which we have reserved for special consideration. We refer to the loss of information in notes and manuscripts belonging to our engineer friends that, being written on perishable paper, without a duplicate, were consumed irretrievably in the flames. One family of engineers, a father and two sons, possessing a large stock of data gathered during two generations of intelligent activity, lost every scrap of knowledge that they had expected to perpetuate in writing, for their own use and for other members of the family. Two engineers who were specialists in dredging and placer mining, possessed of a fine collection of drawings of machinery and records of practice, lost all these. Such instances could be multiplied, but it is not necessary; it requires but little imagination to appreciate the tremendous amount of individual knowledge in written form that perished utterly during the catastrophe. It was individual, and that is why it exists no longer; had it been given to the profession, in the form of literary contributions to technical societies or to professional periodicals, it would be available today, for the benefit of the world at large and incidentally for the use of the men who hugged it closely to themselves. There is no waste so complete as the waste of experience, there is no gift more useful than the record of professional practice. There are men who, from mere laziness, postpone the act of systematizing the data they have collected and the publication of them in such form as will render the information of service to others; for these men one has sympathy, for to be lazy, especially after hard routine work, is human enough. But what shall be said of him who, collecting the little special knowledge that every man can accumulate after a few years of work, prefers deliberately to put it away in a safe, so that the exclusive benefit, if any, of it, may he his and his alone; he makes up his mind that no competitor shall have it, and as for the rest of the world, such as students and the younger fellows whom it might help, why should he give it away to them for nothing? So the greedy tongues of flame sweep through his office and shrivel the selfish manuscript to a cinder. Shall we be sorry for such a man? Yes, but not for his loss of data so much as for the narrow spirit that chooses to live and work to itself.

Sentiment aside, a big fire proves the danger of omitting to duplicate valuable manuscript or even notes and drawings, and of all the ways of multiplying the record, none is so simple as that of putting it into print. Some of us lost the notes of twenty years, but when we realized it there came the pleasant reminder that the best of it had been already put together in the form of material published in transactions and books, of which there were so many copies and so scattered that no single disaster could destroy them all. Whether they were of small or large value mattered little, they were ours, the children of our brain, and they lived, to be a part, however unimportant, of the general reference library of the profession. But we can meet the least altruistic engineer on his own ground, for we venture to say that he who never goes beyond the note book stage or the individual record of work that is prepared for personal use, will never go far and rarely possesses as much as he would if he took the next step, namely, that sifting of data and refining of judgment which are required for the act of publication. Any man who has ever started to put together his information on a particular subject, need not to be reminded how soon he found it was like a garment only half woven, full of holes and unready for use. No one learns as much from his writing as the author, it is an education that continues throughout life, and it is the one that best brings home the limitation of human attainment. So, gentlemen of the profession, put the best that you have into print, for fear of otherwise losing it, and with a purpose generous as the inheritance of knowledge that has come to you without money and without price."

JANUARY ELECTRICAL SHOW AT COLISEUM.

Managing Director Niesz announces the following special days for the January Electrical Show at the Coliseum: Formal opening (invitation), Monday evening, January 14; Northwestern Electrical Association's annual meeting, Wednesday, Thursday and Friday, January 16, 17 and 18; Ben Franklin day (souvenirs), Thursday, January 17; Illuminating Engineers' Society, Friday, January 18; Telephone day, Monday, January 21; Sons of Jove, Tuesday, January 22; Thomas A. Edison day (sonvenirs), Wednesday, January 23; Electrical Salesmen's Association, Thursday, January 24.

The new storage battery which Thomas A. Edison has just completed, and which promises to revolutionize the problem of transportation, will probably be exhibited and demonstrated for the first time. Mr. Edison has been invited to attend the exposition and has intimated that he will probably accept the invitation. If he comes, a special program and banquet will be arranged for Edison day.

The management announces an "Electric Midway" as one of the features for the coming show, for which the main floor of the Coliseum annex will be divided into four small theaters. One of these will be devoted to new demonstrations with static apparatus and high and low frequency current, showing many new and wonderful inventions along these lines and some marvelous results. Another theater will have a new electrical and mechanical creation called the "Aurora Borealis," which will show some beautiful lighting effects, invented and arranged by Edgar Healey of Chicago. In a third theater will be an electrical musical act.

Thirty thousand square feet of space have been sold for general exhibits on the main floor of the Coliseum, but four spaces remaining unsold. Encouraged by the interest the trade and the public took in last year's show, the exhibitors, as a whole, have this year put more money and effort in the arrangement and installation of their displays. Everything that is now in the electrical world will be found, the 200 concerns represented completely covering the electrical field. Director Niesz is making an effort to secure the William J. Hammer collection of incandescent lamps, which represents an effort of twenty-five years in Europe and America, embracing specimens of lamps not only covering the entire art under Edison, dating from his first commercial lamp, the famous "paper horseshoe" lamp of 1879, his plumbago, graphite, bamboo and other vegetable filament lamps, but also the work of all of Edison's contemporaries here and abroad, from this early period to the present time. Mr. Hammer started the collection in 1879, when, at the beginning of Mr. Edison's work, he had charge of certain tests in Mr. Edison's laboratory at Menlo Park, N. J. Mr. Hammer's collection won honors at the St. Louis exposition in 1904 and was given a medal by the Franklin Institute of Pennsylvania in 1906.

DIESEL ENGINES FOR INTERURBAN R. R. SERVICE.

By Norman McCarty*

The statement that high-tension transmission for electric railroad service is made necessary, because of the necessity of installing a steam plant in a few large units centrally located will probably not be questioned.

In other words, if a steam plant could be subdivided into a number of small units, located at intervals in ndependent stations within the limit of low tension direct current transmission, the transformer station would probably be discarded and low tension direct current substituted.

This, however, is impossible with steam units without sacrificing operating economy, and if a low tension system is adopted for long distance operation it must be by installing some internal combustion engine having high fuel economy in small units without a corresponding increase in cost of operating labor.

It does not require any argument to convince the operator of electric railroad properties of the greater simplicity and reliability of the direct current system as compared with any method of alternating current transmission.

The adoption of the alternating current system (either single phase or with rotaries) as stated above, was necessary because of the difficulty and expense of transmitting a current of large volume and low tension over long distance from a central generating plant, **and is never set where transmission distance is within the economical limits of a direct current system.**

The records of the Diesel oil engine in this country and abroad have demonstrated:

1st. The consumption of fuel per brake horsepower in the smallest engine is not 15 per cent. greater than that of the largest units, and in every case is within the builders' guarantee of 12½ gallons of oil for each 100 kilowatt hours delivered in the switchboard under the operating conditions of the system as proposed in this article. **The actual fuel consumption of a 225-brake horsepower unit at full speed being 10¼ gallons for each 100 kilowatt hours at 90 per cent. efficiency of the generator.**

2nd. **That the consumption of fuel per brake horsepower is practically constant from (½) one-half load rater capacity of the engine.**

With the above facts established as they have been by the records of many plants in actual operation, there should be no objection to the installation of Diesel oil engines for the work in so far as relates to fuel economy. It is also safe to assume that **the actual labor required to operate a number of Diesel primary stations will be less than that required for a central steam station together with that needed for the necessary transformer stations.**

The only objections to be raised would refer to the continuity of service, the extreme variation in the load, and small overload capacity of the internal combustion engines, but the installations of a small storage battery in each station successfully meets all of these objections and the desirability of the installation of Diesel engines and low tension direct current as a substitute for steam equipment and high tension current, either with transformers or single phase motors, becomes merely a question of first cost and future operating economy, and the following is offered as a close estimate of the comparative cost for installation and operation of a 50-mile road, with 50-ton cars operating at 30 miles an hour on one headway for 18 hours.

NOTE.

Through an inadvertance in the printing office, a portion of the following excellent article was omitted in our issue of November 24th, and we are republishing the entire article in our present issue.—Editor.

Diesel Engines with Direct Current Low Tension Transmission.

Length of road, 50 miles.

Maximum speeded cars, 30 miles per hour.

Number of cars, 5.

Weight of cars, 50 tons.

Average kilowatt per car, 100 kilowatt (70 watts per ton mile on low tension bus bars).

Number of power stations, 4.

Equipment of each station, one 150-kilowatt direct current, 650-volt unit; one 240-ampere hour battery.

Four engines deliver a total of 600 kilowatts per hour, and 16 hours of actual operation at full load would be sufficient for engine service, making a total output of 9,600 kilowatt hours per day.

The storage batteries would operate the road for the balance of the day, including owl cars and light and power for car barns when engines were idle.

One 240-ampere hour battery per station would be absolutely safe for the purpose.

Total fuel oil required—96x12½, 1,200 gals. at 3 cents, $36.00 cost.

The labor required for operating four stations would be as follows, divided into two shifts of 10 hours each:

One chief engineer and electrician, $5.00 per day.

Eight assistant engineers at $3.00 per day, $24.00.

Total labor per day, $29.00.

Supplies (lubrication and waste), $1.50 per day each station, or for four stations, $6.00 per day.

Operating Expense.

Fuel	$36.00
Labor	29.00
Supplies, Engine	6.00
Total	$71.00

Cost per kilowatt hour (fuel, labor and supplies), $71.00 7.4 mills, 9,600.

Cost per car mile (fuel, labor and supplies), $2.65.

Cost per ton mile (fuel, labor and supplies), 53 of a mill. 100.

The Diesel station would, ever, deliver to the low tension feeders all of the current generated, while the steam plant operating through high tension lines with transformers and rotaries would probably not do better than 65 per cent, so that a steam plant must deliver current on the switchboard at the central power house at not to exceed 5 mills per kilowatt for fuel, labor and supplies to equal the economy of the Diesel engine for current delivered to the low tension feeders.

A discussion of the cost of operating a steam plant is perhaps unnecessary, as this cost will vary with the type of engine installed and the peculiarities of the installation, but in order to make a comparison we will assume that a fair coal consumption for a steam plant of this size operating under the described conditions would not be less than 3½ lbs. per kilowatt hour as shown by watt meter readings on the primary switchboard, and at $2.50 per ton of 2000 lbs. would represent a cost of 4,735 mills for coal alone, to which must be added labor and supplies at the primary station, and labor at the sub-station, which would probably represent 3 mills additional per kilowatt hour, based upon 10,000 kilowatt hours per day of 18 hours, or a total of 7.375 mills per kilowatt hour delivered at low tension feeders against 7.4 mills for the Diesel engine, saving in favor of the Diesel system of about 25 per cent of the steam cost. Furthermore, the fuel cost per kilowatt hour, as shown for the Diesel installation, is at least 20 per cent higher than the actual records show for this type of service, and can be guaranteed, while no one will guarantee the fuel consumption of a steam plant. However, it must be left to the experience of the operator to decide for himself

whether or not his steam plant can deliver one kilowatt hour on the primary station switchboard at a cost of 5 mills under the varying conditions of an electric railroad load, this cost to include every item of expense connected with the main and sub-stations except interest and depreciation.

Cost of Installation.

As the amount of low tension copper would be exactly the same regardless of the system installed, this cost can be eliminated from the comparison of the two systems, so also the cost of the track and bonding.

The cost of each rotary station building would about equal the cost of building for each Diesel station, and we have only to compare the cost of the steam plant, electrical equipment and building, plus the high tension line and transformer station equipments against the cost of the Diesel engines with generators and storage batteries, as follows:

One 225-brake horsepower engine.

One 150-kilowatt direct current generator and switchboard.

One 240-ampere hour 640-volt battery.

Completely installed, including foundation, $35,000.

Of four (4) stations, $140,000.

The Diesel system contemplates an installation capable of delivering a total of 600 kilowatt on the bus bars with practically no losses between switchboard and low tension feeders, but with losses of 35 per cent for high tension system between these points we must install at least 750 kilowatts in the steam station to include these losses and peak loads in order to get a corresponding average output of 600 kilowatts on the low tension side of the sub-stations.

A steam-driven plant for a road of this character, however, would usually install in the power house two 660-kilowatt units, one of which would act as a reserve under usual operating conditions.

Each sub-station would in all probability be equipped with two 300-kilowatt rotary equipments, including step-down transformers and devices necessary for their operation. One of the 300-kilowatt units being relied on as a reserve capacity.

A fair average cost of this equipment, using rotary sub-stations, would be about as follows:

1,200-kilowatt steam station, including engines, boilers, stack, generators, step-up transformers, switchboard and auxiliaries, at $95 per kilowatt, completely installed	$114,000
Building foundations	15,000
50 miles, 3-phase high tension line at $650 per mile	32,500
4 transformer stations equipment complete	64,000
	$225,000

Showing a saving in first cost of $85,000, or about 60 per cent at the cost of the Diesel system.

The installation of the storage battery in connection with the Diesel engine would eliminate any necessity for reserve generating apparatus, as the combined capacity of the generating equipment and storage reserve in each station would be equal to the demand for intervals long enough to meet extreme operating conditions or peak loads.

The items of interest and depreciation (repairs) are in favor of the Diesel installations, as the first cost is less than that of a high tension system, consequently less interest charges and even if we asusme, to avoid argument, that the repairs on the Diesel engines are equal to the combined repairs of steam engine and boiler installations, the expense of maintaining the high tension line and transformer stations would greatly exceed the expense of maintaining the storage batteries connected with the Diesel system.

The above statemnt as presented is exceedingly conservative and probably more favorable to a steam-driven high tension system than the average figures for actual operation on a system of this size would show.

The advantages of the Diesel low tension system are, therefore, presented as follows:

The greater simplicity of the low tension system as compared with any type of high tension.

The greater safety of the low tension system.

A saving of at least 35 per cent in first cost.

The elimination of all troubles peculiar to high tension current due to the transmission line and transformers.

The storage batteries furnish an absolute guarantee for continuous service.

The engine can be operated for a specified fixed time at full load and highest fuel economy, and can be shut down for short periods without effecting the car service.

A saving of at least 33 per cent in actual operating expense.

A saving of interest charges because of the smaller first cost.

A saving in repairs and depreciation by eliminating the principal causes for this expense connected with a high tension system.

Perhaps the strongest argument to be presented in favor of the system proposed next to its simplicity and operating economy is the advantage of being able to build for present needs without in any way affecting the economy, reliability, or flexibility of the line as the future extensions become necessary or additional service added to existing lines.

Each section having its own power equipment, additional sections can be added from time to time and equipped as though they were separate properties, while additional engine units can be added to each station as the service develops and demand for power increases.

The investment can be limited to the immediate necessities without any thought as to future extensions or heavier traffic, with the advantage of decreased interest charges and a much higher operating economy, because the generating units installed are always properly proportioned to the service as it exists at that time.

The smallest system representing a small amount of capital invested can be used as a nucleus for unlimited extension or branches, and for the heaviest service without sacrificing any of the original investment, nor in any way reducing the operating economy or efficiency of the original installation.

LOCATING LIGHTNING ARRESTERS.

A recent number of The Electric Railway Review contains the following in regard to the effective location of lightning arresters:

Mr. H. H. Adams of the United Railways & Electric Company of Baltimore, Md., has devised a novel and effective means for locating spots where lightning seems to strike most often. He is not a believer in the old adage that lightning never strikes twice in the same place, for he has found the contrary to be true. In his office Mr. Adams has a map of the United's system. Whenever a crew reports that a car has been struck at a certain point on the line, Mr. Adams sticks a pin in the corresponding point on the map. It is interesting to observe how these pin holes seem to group together and when a number of discharges have occurred in one locality an arrester is installed there. The use of this method of recording discharges shows that curves and junctions are the most vulnerable points.

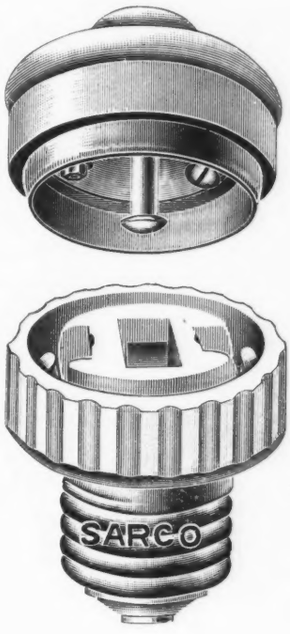
H. W. JOHNS-MANVILLE COMPANY WILL MOVE INTO NEW QUARTERS.

The Boston branch of the H. W. Johns-Manville Company will move, early in December, into a new building at Nos. 55-57-59 High street, Boston. This entire building, which comprises seven floors, will be occupied by the offices.

INDUSTRIAL

A NEW ATTACHMENT PLUG.

A real innovation in attachment plugs is that recently placed on the market by the Sarco Company, 906 Sixth avenue, New York, which they term the Sarco Swivel Separable Attachment Plug. This attachment plug, in addition to being separable, is also swivel, and at the same time will pull apart at any angle, thereby having the advantages of various plugs now on the market "all in one." The accompanying illustration shows the plug open and the plug closed.



By an ingenious locking device in the bottom part of the plug the top part is gripped firmly, and at the same time has a ball-bearing and revolving contact.

The heavy circular band in the top plug makes a contact with two heavy phosphor bronze spring contacts in the bottom plug, making one pole, while the center stud in the top locks into the center of the bottom plug, thereby giving more contact surface to this plug than to any other separable plug made. Should the cord attached to the plug become twisted it is not necessary to separate the plug, but simply revolve the top part, as the top swivels in either direction, and yet at the same time should the cord attached be accidentally struck or strained, the top part would become separated from the bottom part, thereby automatically disconnecting the circuit.

CUT FULL SIZE

In addition to these advantages for heating apparatuses, motors, massage apparatuses, etc., on account of its heavy carrying capacity, it is very advantageous for physicians' appliances, X-Ray machines, charging of storage batteries, etc., as the poles cannot become reversed in the top part of the plug, as in other separable plugs, the center stud always fitting one pole and the outside band connection fitting the other.

It has plenty of room inside of the top part of the plug for a knot in the cord and will take any size of the standard reinforced cord.

ELECTRICAL EQUIPMENT FOR IRON MINES.

The new power plant which Witherbee, Sherman & Co. are erecting on the Lake Champlain shore at Port Henry, New York, furnishes an interesting example of the growth of electricity in mining. It is not generally known that the lower Champlain Lake region produces a goodly proportion of the United States' annual supply of iron ore. The various shafts of this company alone yield from 500,000 to 600,000 tons of iron ore yearly, while with the new electrical equipment the ultimate output will be 1,000,000 tons.

Owing to the fact that the principal shafts of the mines are scattered over a considerable area, electricity has been found to be the most flexible form of power transmission and is almost universally used. Power for this purpose is generated at present both by water and steam. At Mineville there is a steam plant with a 750 kilowatt engine-driven generator which supplies current at 3300 volts for local distribution. This power is supplemented by two small water power plants; a 300 kilowatt water wheel-driven generator unit is located at Wadham's Mills, and a 370 kilowatt unit at Kingdom, about eight miles from this point. At Wadham's Mills a Morgan-Smith water turbine is used, operating under a 48-foot head. Power at the Kingdom plant is furnished by a Pelton impulse wheel, under a head of 290 feet, water being carried through a 32-inch pipe, a distance of 1⅛ miles from the reservoir. These stations are situated about eleven miles from Mineville and deliver current at Mineville at a potential of 6000 volts. This voltage, made desirable because of the saving in transmission, is stepped down to 3300 at Mineville, and is used in conjunction with the 750 kilowatt 3300 volt steam-driven machine to supply power at the various shafts. Induction motors are used for driving hoists, pumps, air compressors, etc., operated at 25 cycles and 440 volts.

The powerhouse which is being built at Port Henry is some six miles from the mines, and will be interconnected with the other sources to supply the increasing demand for power. The station is to be thoroughly modern, being built of monolithic reinforced concrete. Not only the building but the stack will be constructed of this material. "Ironclad" Portland cement manufactured by the Glens Falls Portland Cement Company will be used, mixed with tailings from the mines. Fireproof construction will be employed throughout, and the station is to be a typical example of the use of this building material.

The structure is planned after the Roman style of architecture and is of pleasing design. The main building containing the boilers is 116 feet by 54 feet, while the turbine generator room measures 39 by 59 feet and extends at right angles from the center of the main structure. By making use of the Curtis turbine much floor space is saved and the building is very compactly constructed.

Steam will be generated by four 500 horsepower Babcock and Wilcox boilers, arranged in pairs on either side of a 175-foot stack which occupies about the center of the powerhouse. There is space for two more boilers of the same capacity, one at the side of each pair.

The boilers are hand-fired, and coal is conveyed to each by a car on a track running the length of the building. This car is filled from an overhead hopper through a hinged

shute. The hopper is filled by a vertical bucket conveyor which carries the coal from a pit filled directly from cars outside the building.

The generating equipment comprises an 800 kilowatt Curtis steam turbine generator which will deliver current directly to the line at a potential of 6600 volts and 25 cycles. The compactness of the vertical unit has permitted a remarkably economical disposition of machinery in the generating room. Space is left for the installation of a second turbine which will probably be installed at once.

The switchboard is located in a gallery with a reinforced concrete floor. On this floor is placed also the motor-driven exciter sets, and space is available for two frequency changer lighting sets. A supplementary exciting unit is provided by a 25 kilowatt horizontal Curtis steam turbine generator. The entire electrical equipment for this power-house will be furnished by the General Electric Company.

NEWS NOTES

ELECTRIC RAILWAYS.

Albany, Ore.—It is reported that the Northwestern Utilities Co. has been organized to take over the Albany line; also all the properties of the Willamette Valley Co. in this part of the State.

Boise, Ida.—The Boise Railroad Co., Ltd., has been incorporated with a capital of $900,000 to take over the Natatorium and Boise Traction Co.

Bellingham, Wash.—Stone & Webster have commenced the preilminary surveys for a system of interurban electric roads from this place south into Skagit County. The work already authorized will cost about $2,000,000.

Everett, Wash.—The Everett Street Ry. Co. has begun the work of extending its South Colby avenue track to Forty-fifth street.

Chewelah, Wash.—A six-mile electric railroad will be built from this place to the properties of the United Copper Mining Co. Estimated cost, $50,000.

Olympia, Wash.—The Puyallup Valley Northern Electric Rapid Transit Co. has incorporated with a capital of $3,000,000. The company proposed to build a direct line from Tacoma to this place and on to Orting.

Sedro-Woolley, Wash.—A corporation is being formed for the purpose of constructing an electric road from this city to La Conner. It is being promoted by A. W. Lynn, of San Francisco.

Stratchcona, Alta.—The Stratchcona Radial Tramway Co. has applied for an exclusive franchise for an electric railway to run between this place and Edmonton.

Spokane & Inland Empire.—Officials of the company have just made an inspection trip over the route for the proposed line between Moscow and Lewiston, Ida. F. A. Blackwell, vice-president of the company, announces that the engineering corps will prepare at once estimates of the cost of the 70 miles of line. He indicated it will be only a question of cost and grades. The line will give Spokane direct connection with the Snake River.

United Copper Railway.—Conrad Wolfe of Spokane, president of the company, announces six miles of electric railway will be built from Chewlah, Wash., to the mines, at a cost of $40,000. The line will be used for hauling ore to the Spokane Falls & Northern Railway, giving the mines direct connection with the smelter.

Washington Water Power.—Announcement is made that the company will erect a steam power plant, to cost $500,000, near Spokane, to supplement the water power plant at Post Falls, Ida.

Lewiston & Grangeville.—E. D. Thomas, vice-president of the Commercial Trust Company of Lewiston, Ida., makes the announcement that the building of the electric line between Lewiston and Grangeville is now an assured fact. He added: "Arrangements have been made for the purchase of all supplies, and the contracting engineers will be on the ground in the very near future. The people who are buying the bonds are putting $6,000,000 into the project. Active construction work will be under way in 60 or 90 days, and will be rushed as fast as weather permits."

Traction Line Merger.—Isaac W. Anderson of Spokane has been elected chief executive officer of a company backed by Rhodes, Sinkler & Butcher, bankers of Philadelphia, for the consolidation of fourteen electric power, traction and light plants at Eugene, Springfield, Albany, Cottage Grove, Corvallis, Seaside, Roseburg, Baker City and the traction company at Walla Walla, Wash., and Pendleton, Ore., Dallas and Albany and gas plants at North Yakima, Wash., and Lewiston, Ida. The plants are valued at $6,000,000. It is understood others are to be taken over. A. L. Welch of Portland, Ore., is manager of the consolidated properties.

Drain, Ore.—The Southern Pacific Co. has commenced laying steel on the Drain-Coos Bay grade.

Grand Forks, B. C.—Tracklaying will be commenced at once on the North Fork extension of the Kettle Valley line.

Moorse Jaw, Sask.—The C. P. R. contemplates building the Weyburn line west 100 miles.

Missoula, Mont.—The Northern Pacific Ry. Co. has let a contract to Winston Bros., of Minneapolis, for a new branch line from St. Regis down the Missoula river to Plains. Work will be commenced at once.

New Westminster, B. C.—A party of surveyors are at work resurveying the right of way for the V. V. & E. Ry.

Olympia.—The Chewelah Valley Ry. Co., of Seattle, filed articles of incorporation; capital, $1,000,000. The company is to build and operate a railroad from Nason Siding, 40 miles west of Wenatchee, to Red Mountain, a distance of 30 miles.

Wenatchee, Wn.—It is reported that construction work on the Great Northern branch line from this place to Oroville will begin within 30 days.

Ritzville, Wn.—It is reported that the C. M. & St. P. has abandoned the Lind cut-off and will build a line through Washtucna.

Portland.—The contract for building the Umatilla Central from the main line near Pendleton to Pilot Rock, a distance of 16 miles, has been let to the Pacific Coast Construction Co. Work will be commenced at once.

Pocatello, Ida.—The O. R. & N. is putting in a block system from Ticeska to Reverse, and is putting in a charging plant at Glenn's Ferry to supply the power.

Seattle.—The Haines Mission & Boundary Ry. Co. has been incorporated with a capital of $1,000,000 by Lawrence Arnold, Alban Bunch, John Dalton, E. H. Morrison and Charles E. Wynn-Johnson. The company will construct a line of railroad from the point on Lynn canal at Haines Mission, Alaska, northwest along the Chilcat river to the mouth of the Kleheni, thence along the Kleheni river to the international boundary line at Pleasant Camp.

Tacoma.—All locomotives on the North Bank Railroad from Pasco to Portland are to be equipped with oil burners. Arrangements are now being made between the Northern Pacific purchasing agent here and the Associated Coal Co. of San Francisco, for the supply of oil and the storage tanks. It is understood that the company is considering the use of oil as fuel on the Puget Sound branch of the Portland & Seattle Railroad.

TELEPHONES AND TELEGRAPH.

Ballard, Wn.—The Sunset Tel. Co. was granted permission to erect new poles on Elm St., Langridge Ave., Post. St. and Jefferson Place.

Baker City, Ore.—R. C. Robertson and associates of Portland, have applied for a 20-year franchise for a new telephone system.

Elma, Wn.—S. R. Reaney, of the Sunset Tel. & Tel. Co., reports that a new line to connect with the farmers' line at Satsop is being installed, also that another line will be installed between Satsop and Montesano.

Spokane, Wn.—For the purpose of issuing bonds in a state where they are not taxed to carry on needed improvements, the Pacific States Tel. & Tel. Co. is making arrangements to reorganize as a California corporation.

Wallula, Wn.—C. Truitt, of Spokane, representing the Pacific Tel. Co., is here arranging with members of the farmers' lines to make direct connection with the long distance line.

Weiser, Ida.—H. P. Carr, of Vancouver, B. C., has been appointed manager of the Bell Tel. office at this place.

Wilson Creek, Wn.—The Wilson Creek Tel. Co. will incorporate with a capital of $2,500.

Wilson Creek, Wn.—The subscribers on the Wilson Creek-Krupp telephone line have purchased all of the interest of C. F. Bentley in that line.

Hanford, Cal.—Manager Chas. E. Eldridge of the Sunset Telephone and Telegraph Company received word from the head officer that the plans for the new building had been approved. It is understood that the building will be built on Douty and Eighth streets.

Modesto, Cal.—A new "farmers" telephone line has been organized. Work of construction will soon start. Subscribers are: Frank Gomez, R. L. Thompson and others.

Oakland, Cal.—The Pacific States Telephone Company will commence the erection of the new exchange at Piedmont. As soon as the new building is completed the entire service in Piedmont will be handled from the new exchange, and the prefix Piedmont will take the place of Oakland. The estimated cost of the structure is $40,000

Astoria, Ore.—The Youngs River Tel. Co. elected Joseph Bartoldus president. The line will be extended to Olney at once.

Bellingham, Wash.—The Farmers' Mutual Tel. Co. is building another trunk line to this place from the Lynden district; also a line from Ferndale to Laurel and Shettlers corners will soon be built.

Ashland, Ore.—Spence & Phillips are at work building a new rural line from this place to Dead Indian country.

Bellingham, Wash.—The Laurel Sunset Co. has been organized at Laurel, and will build a telephone line to this place. W. L. Chandler, president.

Condon, Ore.—Louis Doonar sold his telephone system to L. E. Lawrence.

Cheney, Wash.—Ben Berggren, of the P. S. Tel. Co., is here with 18 men putting up copper wires and cross arms from Spokane to Ritzville.

Dayton, Wash.—Sol McCanley states another rural line will be built from George Prater's to this place.

Edmonton, Alta.—Johnson & Warren received the contract for the new telephone building at $22,538. It will be 50x75 feet.

Spokane, Wash.—The Interstate Tel. Co., Ltd., has increased its capital stock from $100,000 to $500,000.

Sunnyside, Wash.—The stockholders of the telephone association amended their charter, changing the name from the Christian So-operative Tel. Association to the Yakima Valley Tel. Co.

Tacoma, Wash.—The Sunset Tel. & Tel. Co. is installing an itner-communicating telephone system in the offices of the Commercial Dock Co.

TELEPHONES AND TELEGRAPH.

Oroville, Cal.—Estimates for a line to secure direct telephone service with San Francisco are about completed. There will be four offices—Oroville, Sacramento, Oakland and San Francisco. The Sunset Telephone Company is constructing it.

Astoria, Ore.—The Young River Tel. Co. voted to extend their system. Joseph Bartoldus, president.

Aberdeen, Wash.—The Sunset Co. will shortly introduce its new telephone system.

Bellingham, Wash.—Within a few days the Sunset Tel. Co. will begin about $25,000 worth of additional conduit work.

Baker City, Ore.—The Pacific States Tel. Co. is making improvements here at a cost of $50,000.

New Westminster, B. C.—Experts have arrived from Montreal and are now engaged in setting up the new switchboard of the B. C. Tel. Co. in the new block on Seymour street.

North Yakima, Wash.—John H. Corcoran, division manager, has made arrangements for extensive improvements and repairs to their system between Seattle and Pasco.

Oakville, Wash.—The Independent Tel. Co. is extending their line to Elma.

Spokane, Wash.—The Pacific States Tel. Co. is stringing two additional copper wires the entire length of their line across Camas prairie.

Seattle, Wash.—J. H. Corcoran, division manager, states that the Pacific States Tel. & Tel. Co. is to reorganize with a capital of $50,000,000. The object is the extension of the system, the greater part of which is to be done in the northwest.

Seattle, Wash.—The Independent Tel. Co. was granted a permit to lay four underground conduits in alley between 2nd and 3rd avenues, from Union street to center of block north of Union.

Bellingham, Wash.—The Sunset Tel. Co. will soon begin about $25,000 worth of additional conduit work.

Conconnully, Wash.—Work has commenced on the construction of the government telephone line that will connect the reservoir site with reclamation headquarters.

TRANSPORTATION.

City of Mexico.—F. Neugebauer of Schoendube & Neugebauer has made arrangements for the immediate construction of the electric street railway for La Compania Industrial de Guadalajara, for which his company received a contract several days ago. The road will cost $300,000.

San Diego, Cal.—The Common Council of San Diego has granted the San Diego Electric Railway Company a franchise for a street railway upon certain streets in the city of San Diego, commencing on D street at the east line of California street and running to the wharf of the Santa Fe Railway Company.

San Diego, Cal.—The Common Council of San Diego has granted a franchise to the San Diego Electric Railway Company for a street railway upon certain streets in San Diego, commencing at the intersection of D and First streets and running to the center of Third street.

Los Angeles, Cal.—A petition has been filed with the council asking for the vacation of portions of ten streets in the northeast section of the city. This has revealed part of the plan of the Los Angeles Interurban Railway Company to extend to some point in the San Gabriel Valley. There is now hope that the line will be constructed within a year.

Los Angeles, Cal.—The Trustees of Redlands will meet Friday night and open bids for the sale of a street railway franchise. N. Buckmaster and A. G. Hubbard were petitioners for such an order of sale. The former is said to represent Walter Kohl, who desires to put an electric line up the Yucsipe Valley to Oak Glen, where a big tourist hotel will be erected.

POWER AND LIGHT PLANTS.

Ashland, Ore.—R. McMurphy and associates have applied for a 25-year franchise for a gas heating, light and power, plant.

Boise, Ida.—The Western Power Co. has been incorporated with a capital of $2, 50,000 by L. A. Choate of this city and J. B. Choate of Atlantic, Ia., to construct a power plant of 20,000 horsepower capacity at the outlet of Ox Bow tunnel.

Granite, Ore.—The Fremont Power Co. is installing an electric power plant, the power for which is generated from Olive Lake and Lost Creek. From the reservoir the water is to be conveyed through 34-inch pope six miles in length, to the power house. The power house is built of concrete blocks. Three 100-kilowatt generators will be installed, connected to the Pelton wheel. A power transmission line is being constructed from the power house to Bourne, a distance of 20 miles.

Lewiston, Mont.—John D. Ryan, Patsey Clark and Daniel Hennessy, of Butte, have agreed on plans for a new power plant to be located on Spring creek. They will also build an electric railway from this city to Kendall.

Seattle.—P. S. Rountree, agent Pacific block, will receive bids until Dec. 10 for an electric elevator, power pumping plant, consisting of pump, motor, tank, air compressor, piping and labor for installing same.

Tenino, Wn.—W. A. Freeburger, of Montesano, has purchased a controlling interest in the plant of the Tenino Light & Water Co.

Helena, Mont.—The Western Union Telegraph Co.'s motive force at its local office will be changed from the gravity to direct electric current. The current for the dynamos will be taken from the lines of the Helena Light & Railway Co.

Missoula, Mont.—The Missoula Light & Water Co. has been incorporated with a capital of $400,000, by W. A. Clark, A. H. Wethy, J. K. Heslet, C. E. McBroom and W. M. Brickford. The company is organized under the laws of the state of Washington and its principal offices will be at Butte and Spokane.

Seattle.—The fire and water committee has recommended for passage the ordinance calling for the installation of light clusters similar to those used in Los Angeles for 2nd avenue, same to be paid for by property holders.

South Park, Wn.—This city has made a contract with the Seattle Electric Co. for the installation of 25 32-candle power lights for street illumination.

Tacoma.—A. L. Thorn and G. B. Fairbanks have filed water rights for a power plant on the Puyallup river. A flume four miles long will carry the water to the power house opposite Cross. The pole line will be 18 miles long. The cost of the plant as projected will be $700.000,

Wenatchee, Wn.—The Wenatchee Electric Co. will increase its capital stock from $25,000 to $150,000. The company plans many extensive improvements.

OIL.

Santa Barbara, Cal.—Frank E. Nelson of this city, acting for the Nelson Liquid Fuel and Burner Company, capitalized at $200,000, will enlarge the plant here and establish State street offices. Plants will be established in other places and the burners will be manufactured on a large scale.

Coalinga.—The Coalinga producers now feel certain that they will soon be receiving fair returns for their investment. It is claimed that the marketing companies are inclined to accede to the demand for beter prices—in fact, a price about 10 cents in advance of that given heretofore has been offered, but was refused. A few more weeks of the present inaction will cause a still greater shrinkage in California oil stocks and the result will be that for which the producers have been waiting for several years past.

WATERWORKS.

Newport Beach—The Townsend-Dayman Improvement Company is carrying on work at Newport Beach on its holdings west of the Southern Pacific tracks. This company has purchased 2400 acres of the mesa just north of this land, which is being dredged. A pumping plant will be installed and a 12-inch main will run up the main avenue. The new townsite will be known as Newport Heights.

Vallejo, Cal.—It has been recommended to the Trustees that a 400 five-inch and one four-inch meter be purchased for the municipal water system.

Redding.—The Redding Water Company will expend about $35,000 to install an auxiliary water system. The present reservoir of the company has 350,000 gallons capacity, and this will be increased to 1,000,000 gallons. A new pumping plant will be put in the river near Jonny Creek.

Los Angeles.—A cement works will be built for the Owens River water system for the city. At Haiwee a great reservoir is to be built. The cost of building the necessary embankment and all other works needed there will not exceed $60,000.

INCORPORATIONS.

San Francisco.—The Santa Cruz Electric Light and Power Company has filed a certificate with the County Clerk announcing the change of the place of its principal office from Santa Cruz to San Francisco. The Union Traction Company and the Co-operative Electric Company, organizations controlled by the same interests, took a like action. John Martin is president of all three companies, and Henry Malloch is secretary. The aggregate paid-up capital affected by the change is $395,000, of which $300,000 belongs to the Santa Cruz Electric Light and Power Company, $50,000 to the Co-operative Company and $45,000 to the Union Traction Company. Resolutions deciding on the change of location were passed by the Union Traction Company on July 16th, the other organizations voting in favor of the project on August 20th.

Yerington, Nev.—At a meeting held here last week the Nevada, Mason and Los Angeles Railway Company was formed. The company is capitalized for $1,000,000, with shares at a par value of $10, and the following officers have been named: Newton Evans of Los Angeles, president; J. I. Wilson, vice-president; E. W. Fairbanks, secretary, and J. G. Kaufman, treasurer. The purpose of the company is to build an electric road from Wellington to Wabuska in Nevada and to have the line connect with Southern roads running into Los Angeles. The company is backed by Los Angeles capitalists, and Los Angeles expects the trade of a rich mining district of Nevada as a result of the building of the road. The power of the new road will be furnished by the Truckee River General Electric Company.

TRANSPORTATION.

Santa Barbara, Cal.—Work on the eastern extension of the street car system will be rushed as soon as the company can secure the rights of way. It will be only a few months before the trolley will reach Summerland. The Edison Company is also figuring on a line along the foothills, from Mission to Montecito, and this matter will be taken up in the near future. B. F. Pierson, Superintendent of the Edison Electric Company, believes that Santa Barbara and Los Angeles will be connected by an electric line.

Los Angeles, Cal—The probable route of the new motor line which is to first link Pasadena and La Canada, via Sierra Madre, and finally run into Los Angeles, is announced. It is said that the survey has been completed from La Canada along the west bank of the arroyo seco through Linda Vista and the Campbell-Johnson ranch, crossing the arroyo into Pasadena, south of Devil's Gate.